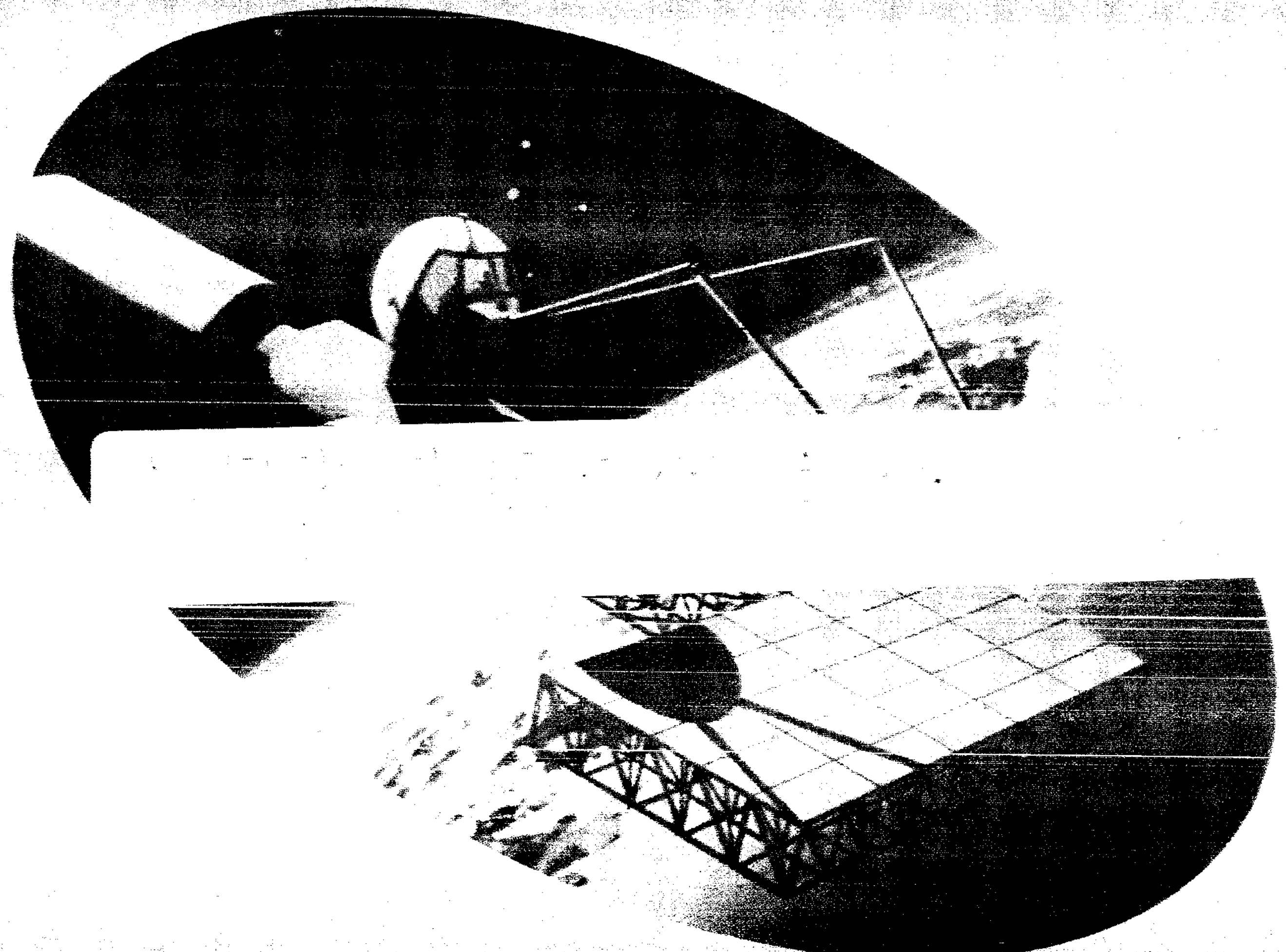
IN-SPACE RESEARCH, TECHNOLOGY AND ENGINEERING (RT&E) WORKSHOP

VOLUME 4 OF 8

SPACE ENVIRONMENTAL EFFECTS



NATIONAL CONFERENCE CENTER
WILLIAMSBURG, VIRGINIA
OCTOBER 8-10, 1985

NASA
National Aeronautics and Space Administration

Langley Research Center
Hampton, Virginia 23665

OAST
Office of Aeronautics and Space Technology
Washington, DC

NOTICE

The results of the OAST Research, Technology, and Engineering Workshop which was held at the National Conference Center, Williamsburg, Virginia, October 8-10, 1985 are contained in the following reports:

VOL 1	Executive Summary
VOL 2	Space Structure (Dynamics and Control)
VOL 3	Fluid Management
VOL 4	Space Environmental Effects
VOL 5	Energy Systems and Thermal Management
VOL 6	Information Systems
VOL 7	Automation and Robotics
VOL 8	In-Space Operations

Copies of these reports may be obtained by contacting:

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SPACE ENVIRONMENTAL EFFECTS

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FOREWORD

Within NASA, the Office of Aeronautics and Space Technology (OAST) has the responsibility for timely development of needed new technologies. Traditionally, the development of new concepts, new materials, designs, and engineering techniques for aeronautics has been accomplished in close cooperation with the aircraft industry and with the great American universities. On the other hand, NASA, as the primary user of space flight, has been its own principal customer for new space technologies.

A new era of permanent presence in space is beginning with the Space Station. This permanent presence will permit and promote commercial ventures and privately funded research in the tradition of university/industry cooperation.

The RT&E workshop in Williamsburg represents a significant milestone for NASA and the space engineering community. It marked the initiation of a long-term program of outreach by NASA to focus the needs of universities, industry, and government for in-space experiments and to begin building a strong national user constituency for space research and engineering.

These proceedings represent a "first-cut" planning activity to involve universities, industry, and other government agencies with NASA to establish structure and content for a national in-space RT&E program. More interactions are needed - more workshops will follow. Program adjustments will be made. A truly national program will evolve, and its beginnings are presented here with the hope and determination needed to make it a program we can all take pride in.

- Raymond Colladay

INTRODUCTION

Among the purposes of the Research, Engineering, and Technology Workshop, an interest in validating the RT&E theme concept has some direct effect on the form of these proceedings. The original five themes, which were themselves a target for validation or recommeded changes, have become seven. During preparations for the workshop, the submitted papers and attendance plans made it evident that the fifth "theme", In-space Operations, was too broad, and would need to be split. As the workshop got underway, a further split occurred, brought about by the different levels of maturity, and needs for technology planning in several sub-disciplines. Thus, these proceedings are presented under seven themes. The volume of presentations, and the quantity of information generated by the individual panel summaries has led to the decision to prepare the proceedings in several volumes.

The first volume is an executive summary and includes the summary presentations made by the panel co-chairmen in the final plenary session. The accompanying seven volumes, of which this is one, each represent a specific "theme", and include the un-edited original presentation material used in that particular panel workshop. Each of these separate "theme" volumes also include the Foreword, the general Summary and Conclusions, and the Chairman's presentation charts and narrative summary. Thus, each should represent a self-standing volume to reflect the proceedings relevant to its respective Panel deliberations and output, as well as the reflection in the general Workshop results.

WORKSHOP THEME

Space Environmental Effects

- --Material Durability
  - --Atomic Oxygen
  - --Ultraviolet/Vacuum
  - --Electron/Proton
- --Plasma
- --Contamination

SUMMARY AND CONCLUSIONS

NASA's In-Space Research, Technology, and Engineering (RT&E) Workshop brought together representatives of the university community, private sector, and government agencies to discuss future needs for in-space experiments in support of space technology development and the derivative requirements for space station facilities to support in-space RT&E.

The workshop provided an excellent forum for establishing an interactive process for building a national in-space experiments program. It enabled NASA to present to the user community (university and private sector) experiment concepts for NASA's technology development activities in support of future space missions. The meetings also began a process by which industry and university researchers will be able to bring their own TDM requirements to NASA's planning process.

This conference reached three primary goals: first, it expanded and validated NASA's in-space experiment theme areas, including Space Structure (Dynamics and Control), Space Environmental Effects, Fluids Management, Energy Systems and Thermal Management, Automation and Robotics, Information Systems and In-Space Operations; second, it began the development of a user community network which will interface with NASA throughout the lifetime of the in-space experiment program; and third, it formed the basis for the establishment of on-going working groups which will continue to interest and coordinate requirements for in-space RT&E activities.

As an adjunct to the conference, NASA/OAST announced plans to initiate a long-term program to encourage and support industry and university experiments. NASA's modest investment in this program is initially targeted for generating experiment ideas and concepts. It is anticipated that this base of concepts will lead to cooperatively funded experiments between NASA, industry, and academia and thereby, begin to build an active in-space RT&E program.

Several key points emerged from this conference regarding the adequacy of the TDM data base that should be addressed in future planning activities. First, many of the experiments could be performed on the ground, i.e., they do not justify a space experiment. Secondly, many of the experiments address near-term or current applications and do not take into account advanced system requirements. The TDM data base must look beyond extensions of current programs to reflect future needs and trends to have an effective and useful impact on space station planning and design. This will require increased input from industry and university researchers and engineers.

In order to address these concerns, it is imperative that a long-range planning view be taken in which industry and university researchers help NASA derive the technology development program. The following recommendations have been developed on the basis of the workshop:

1. Development of an on-going RT&E university and industry advisory group;
2. Continuation of in-space RT&E symposia to act both as outreach mechanisms and as working sessions to refine the TDM data base;
3. Development of an RT&E information clearinghouse;
4. Development and continuation of the new experiments outreach activity announced at the RT&E workshop;
5. Development of an "impacts assessment group" which will focus its energy on identifying experiment accommodation requirements to impact the design of in-space facilities, i.e., space station and others.

If carried out, these recommendations constitute movement toward development of an effective NASA/industry/university partnership in a National In-Space RT&E Program. This will also enable NASA/OAST to have an effective voice in space station planning, which is essential toward the success of a future in-space activities. The workshop, by promoting the process of NASA/industry/university interactions and by pointing out concerns with the developing TDM data base has provided an important first step towards a successful long-term space technology development effort.

IN-SPACE RESEARCH, TECHNOLOGY, AND ENGINEERING WORKSHOP

SPACE ENVIRONMENTAL EFFECTS

MICHAEL A. GREENFIELD	OAST	CO-CHAIRMAN
STANLEY A. GREENBERG	AEROJET ELECTROSYS.	CO-CHAIRMAN
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JANE A. HAGAMAN	LANGLEY RES. CTR.	EX-OFFICIO
WALT JADERLUND	JOHNSON SPACE CTR.	EX-OFFICIO

1-13
26017
128.

SPACE ENVIRONMENTAL EFFECTS SUMMARY

Michael A. Greenfield

This Panel directed itself to reviewing space environmental effects experiments developed to increase the understanding of the service environment and interactions. Overall, the experiments that were presented fell into three major categories. The first were those experiments directed to the development of a space environmental database, taking into account synergistic and multi-parameter effects that cannot be simulated on the ground. The second broad area included those experiments that would allow for validation of ground-based developed models. Only through confidence in these ground-based models can accelerated-life predictions of material response be made accurately. The last area were a group of experiments directed toward exploiting beneficial effects of the space environment such as atomic oxygen cleaning, magnetic altitude control, material modification, etc.

The 26 presented experiments fell into two main areas: those related to environmental definition and those related to the interactive effect of the environment on either the surfaces or bulk properties of materials. The Panel attempted, during this preliminary review of the experiments, to define overlapping technology issues, some measure of cost benefit and time sequencing. It was clear that, in order to maximize the experiment's utility, it was necessary to evaluate experiments as to those that were providing benchmark data; those that would provide an on-going update of the database needed for design; and those that provided mechanistic understandings that would allow for more meaningful ground test and ground test validations. There appeared to be in the group of experiments reviewed a commonality of instrumentation needs. Furthermore, it is felt that not all of the presented experiments actually required in-space Space Station evaluation. Opportunities for either ground test, orbiter flight or free flyers were also evaluated.

It was felt that in order to provide the opportunity for more meaningful environmental-effect experiments on Space Station, certain accommodations would be necessary. Although the needs for power utilities, data collection and transmission lines were not considered to be show-stoppers, there was a need for placement on the Station in areas that were well defined so that experiments could be evaluated as for space environmental effects only and not produce misleading data from contamination. The Panel, working with the audience which was composed of about 50% industry and university people and 50% NASA people, attempted to define what were reasonable short-term achievable goals. It was felt that among these were the ability to characterize the Station environment, develop a common cost-effective instrumentation pool that all experimenters might use and, at least, initially predict material and component performance for the generation of some preliminary engineering data. In the longer term, it was felt that design enhancements for growth Station could be developed; the role of the space environment as a beneficial environment for exploitation could be evaluated; and improvements in the long-term reliability of components could be achieved.

PHILOSOPHY FOR IN-SPACE ENVIRONMENTAL EFFECTS EXPERIMENTS

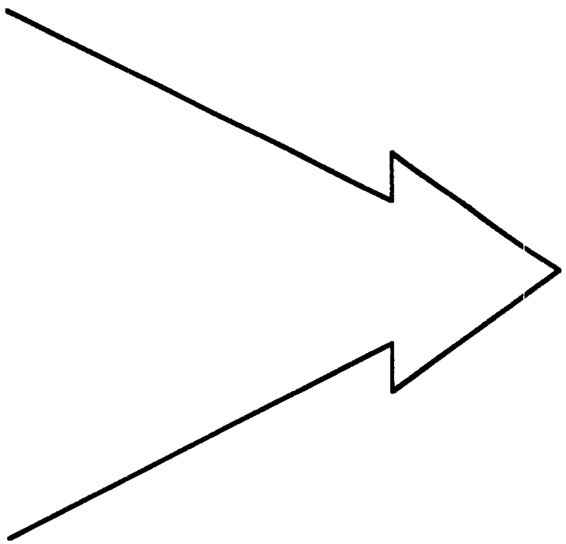
- o DEVELOP SPACE ENVIRONMENT ENGINEERING DATA BASE
  - SYNERGISTIC EFFECTS/MULTI-PARAMETER EFFECTS
  - NOT SIMULATABLE ON GROUND
- o VALIDATE GROUND BASED EXPERIMENTS/MODELS
- o EXPLOIT BENEFICIAL EFFECTS
  - ATOMIC OXYGEN CLEANING
  - MAGNETIC ATTITUDE CONTROL
  - TETHER EFFECTS
- o DISCOVER NEW APPLICATIONS
  - ENGINEERING TECHNOLOGIES
  - SCIENTIFIC ADVANCEMENT
  - COMMERCIAL PAYOFFS

MAJOR EXPERIMENTAL AREAS

ENVIRONMENT

DEFINITION

- NATURAL
- INDUCED



INTERACTION EFFECTS

SURFACE

- DEGRADATION OF MATERIALS PROPERTIES
- OPTICAL/THERMAL/MASS LOSS

BULK

- ELECTRONICS
- BIOTECHNOLOGY

PANEL 3: WORKSHOP PRESENTATION SCOPE

ENVIRONMENT	EXPERIMENT CATEGORIES: ENVIRONMENTAL DEFINITION		EXPERIMENT CATEGORIES: INTERACTION EFFECTS	
	NATURAL	INDUCED	EXTERNAL	INTERNAL
MAG. GRAV., ELEC. FIELDS			X	X
EMI	O	X	X	O
PLASMA	X	X	X	
PARTICULATE RADIATION	X			X
SOLAR EM RADIATION			X	
CONTAMINATION	X	X	X	X
MICROMETEROID/DEBRIS		O	X	
ATMOSPHERIC INTERACTIONS	X	X	X	

X: ADDRESSED IN WORKSHOP

O: NOT COVERED IN WORKSHOP, BUT NEEDED

METHODOLOGY FOR EXPERIMENT DEFINITION

- DEFINE OVERLAPING TECHNOLOGY ISSUES
- COST BENEFIT ANALYSIS/ENGINEERING UTILITY
- SEQUENCING
- TRANSITION TO USER COMMUNITY

MAXIMIZE EXPERIMENT UTILITY

- BENCHMARK EXPERIMENTS
- ON-GOING DATA BASE UPDATE
- FEED DESIGN GUIDELINES
- DEVELOP MECHANISTIC UNDERSTANDING
- INSTRUMENTATION COMMONALITY AND FACILITY SELECTION

COMMONALITY OF INSTRUMENTATION

INSTRUMENTATION (TOOL BOX)	EXPERIMENTAL CATEGORIES			
	ENVIRONMENTAL		EFFECTS	
	NATURAL	INDUCED	EXTERNAL	INTERNAL
GAS PHASE	X	X	X	X
SURFACE			X	X
PLASMA	X	X	X	X
RADIATION	X	X	X	X
MECHANICAL PROPERTIES			X	X
DATA ACQUISITION	X	X	X	X

EXPERIMENTAL FACILITY FOR SPACE ENVIRONMENT EFFECTS

	ADVANTAGES	COMMENTS
GROUND	o CONTROLLED ENVIRONMENT o DETAILED STUDIES o LOWER COST	o NOT TOTAL ENVIRONMENTAL TEST
ORBITER	o MANY FLIGHT OPPORTUNITIES o TOTAL ENVIRONMENT	o OPERATIONS MUST BE CONTROLLED o SHORT MISSIONS
FREE FLYER	o GREATER VARIETY OF SPACE ENVIRONMENTS o CONTROL OF INDUCED ENVIRONMENTS o LONG EXPOSURES	o FEWER OPPORTUNITIES o SAMPLE RECOVERY DIFFICULT
SPACE STATION	o TOTAL ENVIRONMENT o LONG EXPOSURES WITH ACCESS TO SAMPLES o ON-ORBIT INSTRUMENTATION/DATA ANALYSIS o ALLOWS MODEL VALIDATION	o INDUCED ENVIRONMENT MUST BE MINIMIZED

SPACE STATION ACCOMMODATIONS FOR ENVIRONMENTAL EFFECTS EXPERIMENTS

LOCATIONS ON STATION

- o "CLEAN" ZONES/NATURAL ENVIRONMENT DEFINITION
  - NO STATION EFFLUENTS
  - NO ELECTROMAGNETIC EMISSIONS
  - ADEQUATE STRUCTURAL SUPPORT
- o REGIONS INSIDE AND NEAR MODULES/INDUCED ENVIRONMENTAL EFFECTS
- o ATTITUDE CONTROL

UTILITIES

- o POWER ($\leq$2 KW AVG.)
- o MODEST COOLING
- o ELECTRICAL GROUNDS
- o CONSUMABLES
  - CRYOGENIC FLUIDS
  - GASES

DATA COLLECTION/TRANSMISSION

- o LONG TERM, LOW RATES

OPERATIONS AND MAINTENANCE

- o EVA
- o ROBOTICS
- o OPERATIONS SCHEDULE/LOG

ACHIEVABLE GOALS

SHORT TERM

- CHARACTERIZE THE STATION ENVIRONMENT
- DEVELOP COMMON, COST EFFECTIVE INSTRUMENTATION POOL
- PREDICT MATERIALS AND COMPONENT PERFORMANCE
- ENGINEERING DATA BASE

LONGER TERM

- DESIGN ENHANCEMENTS FOR GROWTH STATION
- BENEFICIAL EXPLOITATION OF SPACE ENVIRONMENT
- IMPROVED LONG TERM RELIABILITY OF COMPONENTS
- CONTINUALLY UPDATED DATA BASE

THE NEXT STEP

- OVERALL TOP DOWN STRUCTURED GUIDELINES AND MILESTONES FOR PARTICIPATION
- DESIGNATE OAST ADVOCATE
- FORMALIZE INFORMATION EXCHANGE
- ESTABLISH AN EXPERIMENT COORDINATION OVERSIGHT TEAM
- ESTABLISH WORKING GROUPS IN KEY AREAS
- DEVELOP/IMPLEMENT INDUCEMENT PROGRAM

THEME

PRESENTATION

MATERIAL

ATOMIC OXYGEN EFFECTS EXPERIMENT

JAMES VISENTINE

JSC

INTRODUCTION

- OVER THE LAST 4 YEARS, A LARGE AMOUNT OF SPACE HARDWARE HAS BEEN RECOVERED AFTER EXPOSURE FOR VARYING PERIODS OF TIME TO THE LOW EARTH ORBITAL (LEO) ENVIRONMENT
- EXAMINATION OF THIS RETURNED HARDWARE REVEALS SIGNIFICANT DEGRADING EFFECTS ON MATERIALS PRODUCED BY THE LEO EXPOSURE
  - MASS LOSS FOR ORGANIC SURFACES - AS MUCH AS 10 μm FOR SHORT EXPOSURES
  - CHANGES IN SURFACE MORPHOLOGY AND CHEMISTRY RESULTING IN PROPERTY CHANGES
- OBSERVED EFFECTS ARE CONSISTENT WITH A MECHANISM INVOLVING ATOMIC OXYGEN OXIDATIVE ATTACK OF EXPOSED SURFACES
- DEGRADATION RATES ARE SUFFICIENTLY HIGH THAT COATINGS OR ATOMIC-OXYGEN-DURABLE MATERIALS WILL BE REQUIRED FOR CERTAIN SPACECRAFT AND WILL BE EXTENSIVELY REQUIRED ON SPACE STATION

EXPERIMENT RESULTS

- OF THE TWO GENERAL CLASSES OF MATERIALS, METALS AND NONMETALS, METALS ARE THE LEAST REACTIVE (CARBON, OSMIUM, AND SILVER ARE EXCEPTIONS)
- FLUOROPOLYMERS AND SILOXANES ARE, GENERALLY, LEAST REACTIVE OF THE NONMETALS
- ORGANICS (MATERIALS CONTAINING CARBON, HYDROGEN, NITROGEN, AND OXYGEN) ARE GENERALLY HIGHLY REACTIVE WITH THE LEO ENVIRONMENT:
  - ADDITIVES REDUCE INTERACTION RATES BY SHADOWING ORGANIC MATRICES FROM INCIDENT OXYGEN BEAM
  - REACTION RATES, TO A FIRST APPROXIMATION, ARE NOT INFLUENCED BY IONIC CONSTITUENTS OR SOLAR UV RADIATION
  - SCATTERING BY ADJACENT SURFACES (THERMALLY ACCOMMODATED OXYGEN ATOMS) CONTRIBUTE TO RECESSION RATES

REACTION EFFICIENCIES FOR COMPOSITES, POLYMERS, AND ORGANIC FILMS

MATERIAL	REACTION EFFICIENCY cm^3/ATOM
KAPTON	3.0×10^{-24}
MYLAR	3.4
TEDLAR	3.2
POLYETHYLENE	3.7
PMMA[a]	3.1
POLYIMIDE	3.3
POLYSULFONE	2.4
1034C EPOXY	2.1
5208/T300 EPOXY	2.6
TEFLON, TFE	<0.05
TEFLON, FEP	<0.05

[a]PMMA = POLYMETHYLMETHACRYLATE

SPACE STATION CONSIDERATIONS

- UNPROTECTED SPACE STATION SURFACES WILL BE EXPOSED TO HIGH VALUES OF ATOMIC OXYGEN FLUENCE AND UNDERGO MASS LOSS DURING AN 11-YR SOLAR CYCLE:

SURFACE	FLUENCE (ATOMS/cm^2)	SURFACE RECESSION (MILS/μm)
TOWER STRUCTURE[1]	1.2×10^{22}	14/360
SOLAR ARRAYS	6.7×10^{21}	8/200
RADIATORS[2]	7.7×10^{21}	0.2/5
INFLATABLE STRUCTURES[3]	6.7×10^{21}	9/225

1 ASSUMES GRAPHITE-EPOXY COMPOSITE ELEMENTS

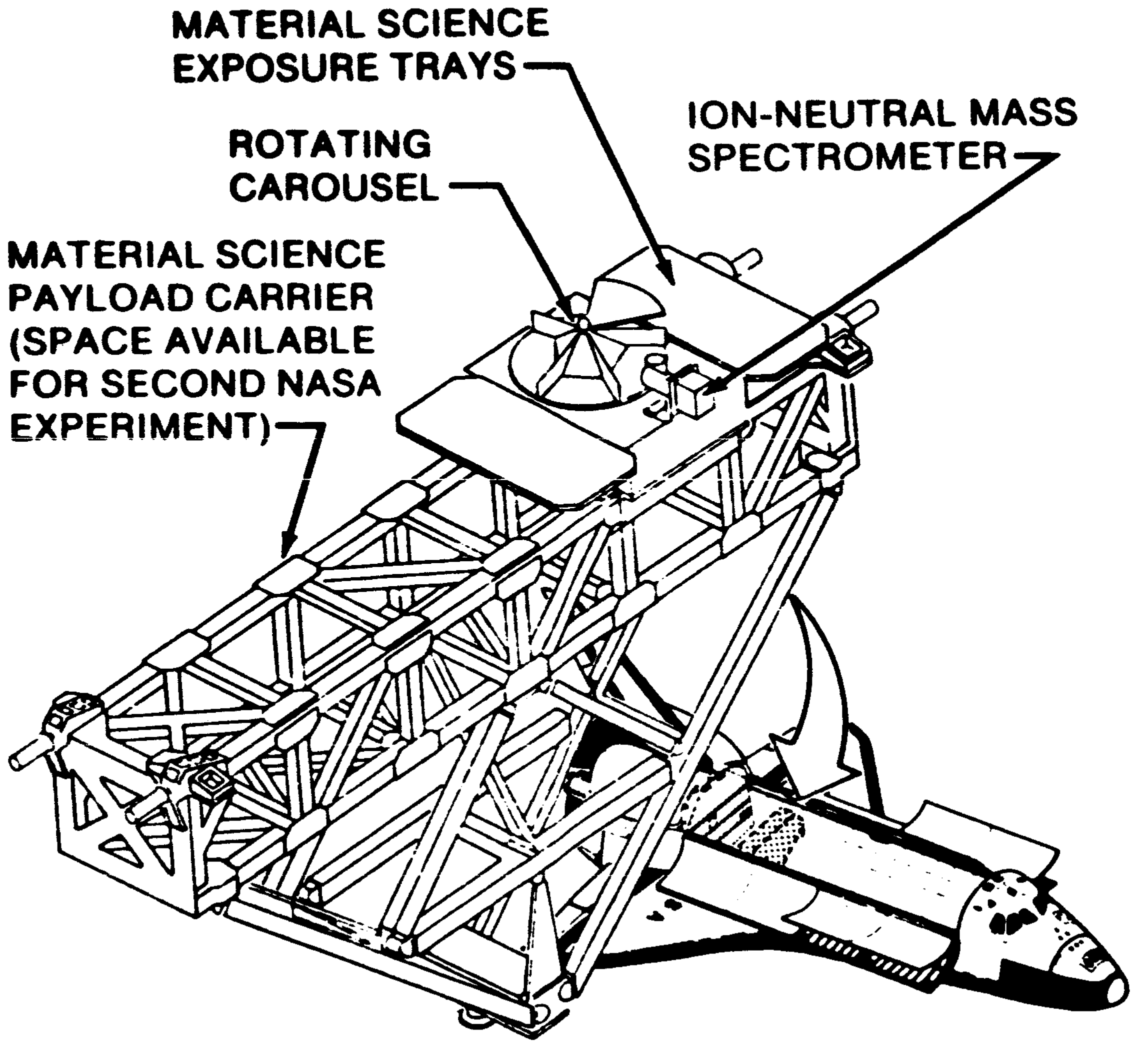
2 ASSUMES TEFLON OUTER SURFACE

3 ASSUMES MYLAR/TEDLAR MEMBRANES

PROTECTIVE TECHNIQUES

- SPACE STATION STRUCTURES CAN BE PROTECTED FROM THE LEO ENVIRONMENT BY COATING THEM WITH METAL OXIDES OR FLUOROPOLYMERS HAVING LOW REACTION RATES:
  - SOLAR ARRAYS — TEFLON OVERCOATS
  - COMPOSITE STRUCTURES — METAL OXIDES, FLUOROPOLYMERS, OR METAL OXIDES CODEPOSITED WITH FLUOROPOLYMERS
  - RADIATORS — METALLIZED POLYMER COATINGS INTEGRAL WITH BASIC STRUCTURE
  - INFLATABLE STRUCTURES — TEFLON OVERCOATS
- COATINGS MUST BE DURABLE AND LIGHTWEIGHT AND MUST MAINTAIN OPTICAL AND MECHANICAL PROPERTIES OVER SPACE STATION INTENDED LIFETIME
- COATINGS MUST BE COST-EFFECTIVE AND EASY TO APPLY

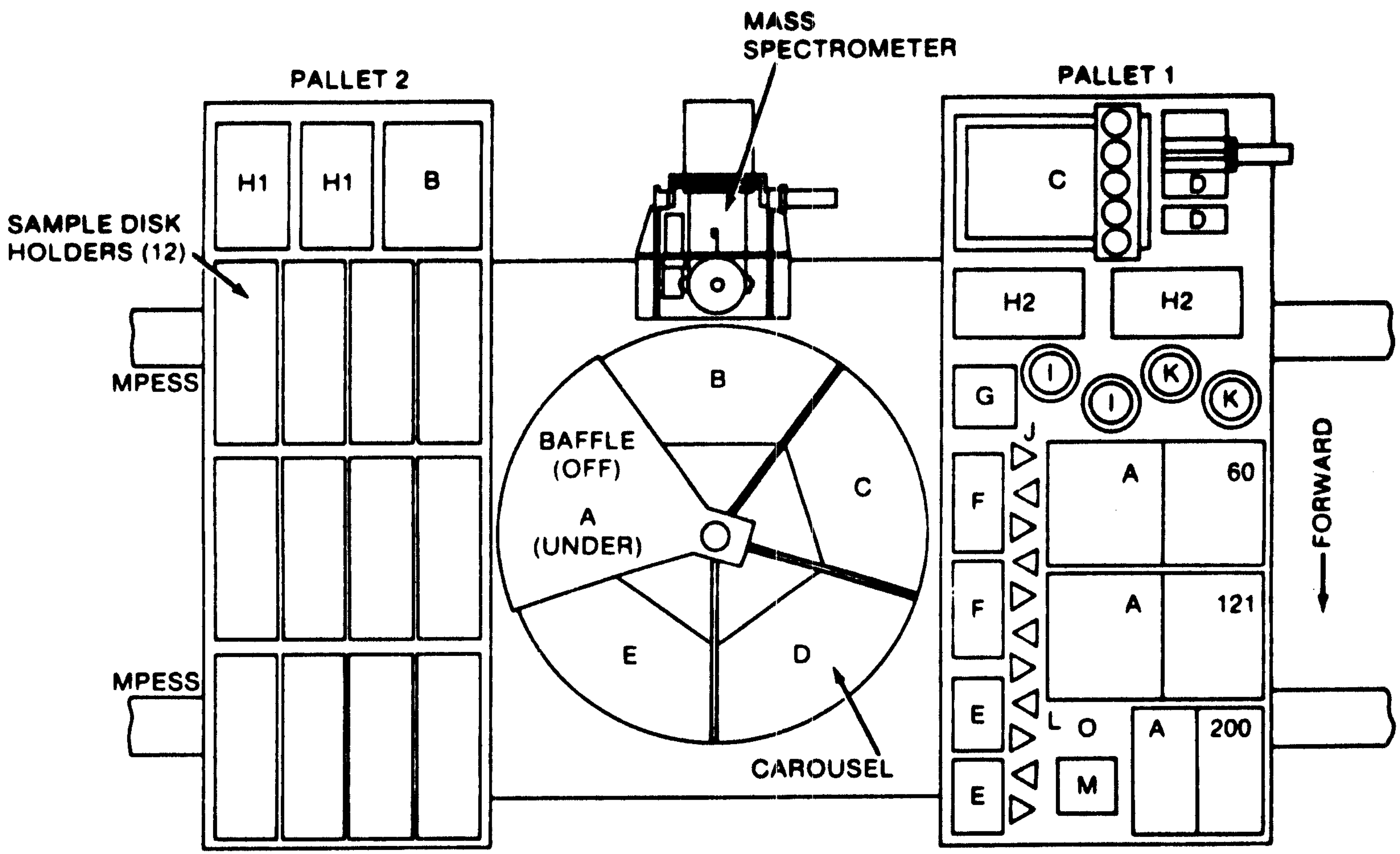
EOIM-3 ATOMIC OXYGEN EFFECTS EXPERIMENT



MEASUREMENT APPROACH

- USE ION-NEUTRAL MASS SPECTROMETER (MS) TO OBTAIN AERONOMY MEASUREMENTS AND STUDY ATOM-SURFACE INTERACTION PRODUCTS
- PROVIDE MS ROTATING CAROUSEL SYSTEM CONTAINING "MODELED" POLYMERS FOR MECHANISTIC STUDIES
- PROVIDE ACTIVE AND PASSIVE TRAYS FOR REACTION RATE MEASUREMENTS
- STUDY EFFECTS ON TEMPERATURE, UV EXPOSURE, MECHANICAL STRESS, AND SURFACE-ATOM SCATTERING CHARACTERISTICS ON RECESSION RATES
- DESIGN EXPERIMENT TIMELINE TO PROVIDE THE REQUIRED EXPOSURE (2×10^{20} ATOMS/cm^2)
  - ALTITUDE 222 km (120 N. MI.)
  - ATTITUDE +ZVV (NORMAL IMPINGEMENT)
  - INCLINATION 28.5°
  - FLIGHT DATE EARLY 1987

EOIM-3 ATOMIC OXYGEN INTERACTION EXPERIMENT



EXPERIMENTS:

A - HEATED PLATE (JSC), 3 EA
B - ATOM SCATTERING EXPERIMENT (UAH), 1 EA
C - ENVIRONMENT MONITOR PACKAGE (GSFC), 1 EA
D - SOLAR UV EXPERIMENT (JSC), 1 EA
E - STATIC STRESS FIXTURE (MSFC), 2 EA
F - UNIFORM STRESS FIXTURE (MSFC), 2 EA
G - ATOMIC OXYGEN MONITOR (MSFC), 1 EA
H1 - COMPOSITE STRESS FIXTURE (LaRC), 2 EA
H2 - COMPOSITE STRESS FIXTURE (JSC), 2 EA
I - SCATTEROMETER (JPL), 2 EA
J - MECHANICAL STRESS FIXTURE (LeRC), 11 EA
K - REFLECTOMETER (LeRC), 2 EA
L - PINHOLE CAMERA (LeRC), 1 EA
M - SCATTEROMETER (AEROSPACE CORP.), 1 EA

EXPERIMENT STATUS

- PROGRAM PLAN AND STS FORM 100 APPROVED BY NASA HEADQUARTERS (SPACE STATION AND OAST)
- EXPERIMENT CONFIGURATION AND OPERATIONAL TIMELINE APPROVED BY INTER-AGENCY WORKING GROUP
- EXPERIMENT DEVELOPMENT TO COMPLY WITH CDR DIRECTIVES
- CRITICAL DESIGN REVIEW SCHEDULED DURING OCTOBER 1985
- EXPERIMENT TO SUPPORT FLIGHT READINESS DATE OF SEPTEMBER 1986

CONCLUSIONS

- EOIM-3 EXPERIMENT TO PROVIDE A RELIABLE MATERIALS INTERACTION DATA BASE FOR SPACE STATION DESIGN
- AERONOMY MEASUREMENTS WILL PROVIDE MORE DETAILED UNDERSTANDING OF IONOSPHERIC PROCESSES AND WILL VERIFY AMBIENT DENSITY MODELS
- EFFECTS OF TEMPERATURE, MECHANICAL STRESS, SOLAR RADIATION, AND ESTIMATION OF ENERGY ACCOMMODATION BY VARIOUS SURFACES WILL SERVE AS INPUTS TO MATERIAL SELECTION DATA BASE
- DEVELOPMENT OF LOW-REACTIVITY MATERIALS AND/OR PROTECTION TECHNIQUES ARE IMPORTANT CONSIDERATIONS IN EXTENDING THE LIFETIME OF SPACE STATION STRUCTURES AND COMPONENTS

TDMX 2011 - SPACECRAFT MATERIALS AND COATINGS

EXPERIMENT OBJECTIVE

- ESTABLISH A TECHNOLOGY BASE FOR THE DEVELOPMENT OF ADVANCED MATERIALS AND COATINGS FOR LONG-TERM USE IN SPACE ENVIRONMENT.

TDMX 2011 - SPACECRAFT MATERIALS AND COATINGS

EXPERIMENT DESCRIPTION

- THREE PANEL SECTIONS ON SPACE STATION:
  1. ON POWER TOWER TRUSS STRUCTURE FACING VELOCITY VECTOR
  2. ON POWER TOWER TRUSS STRUCTURE FACING WAKE
  3. ON SOLAR ARRAY TRUSS STRUCTURE FACING SUN

- VELOCITY-FACING PANELS WILL HAVE 6 TRAYS INSTALLED/REMOVED BY RMS WITH EVA FOR POWER AND ELECTRICAL CONNECTIONS.

- OTHER TWO PANELS WILL HAVE 3 TRAYS EACH.

- PANELS WILL HAVE SPECIMEN EXPOSURE TRAYS; SOME TRAYS WILL HAVE REMOTELY CONTROLLED COVERS.

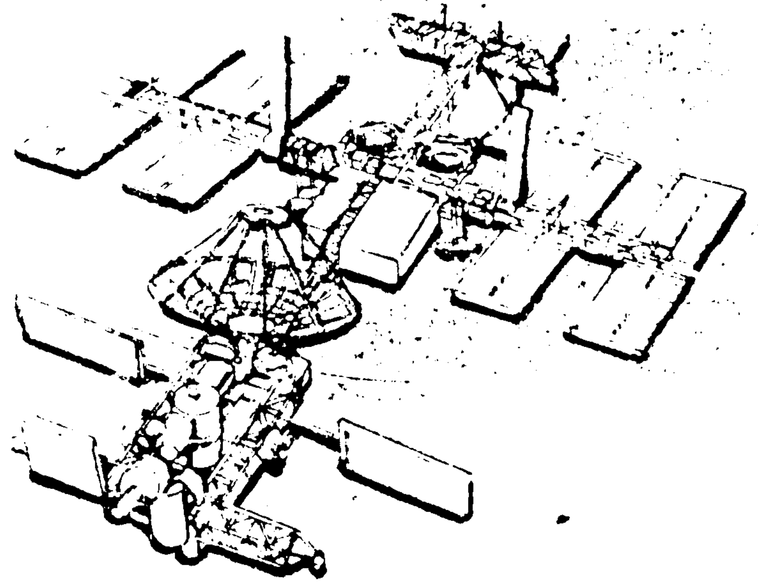
- ALL PANELS WILL REQUIRE POWER AND DATA LINKS.

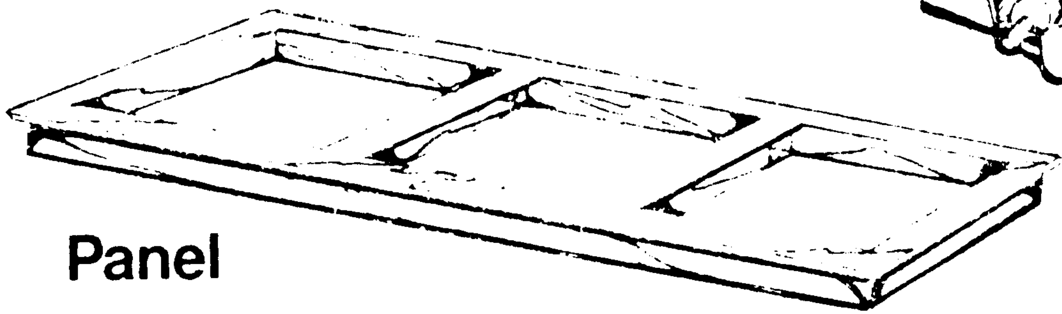
- COMMANDS NEEDED FOR INSTRUMENT ACTIVATION, DATA COLLECTION, SPECIMEN TEMPERATURE CONTROL, AND CANISTER OPENING/CLOSING.

- TYPICAL TRAY CHANGE-OUT AT 90-DAY INTERVALS.

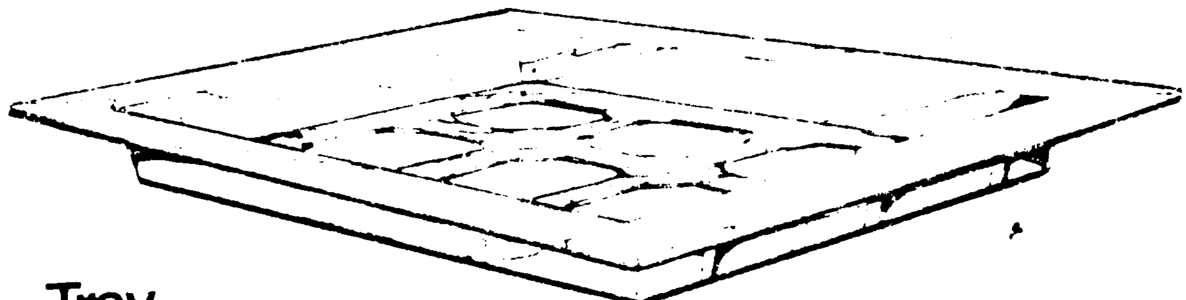
- MATERIALS/ENVIRONMENT MONITORS: SOLAR (UV) FLUX, ATOMIC OXYGEN FLUX, TEMPERATURE, SOLAR FLARE ACTIVITY, SAMPLE MASS LOSS, OPTICAL PROPERTY MEASUREMENTS.

Space Environmental Exposure Facility



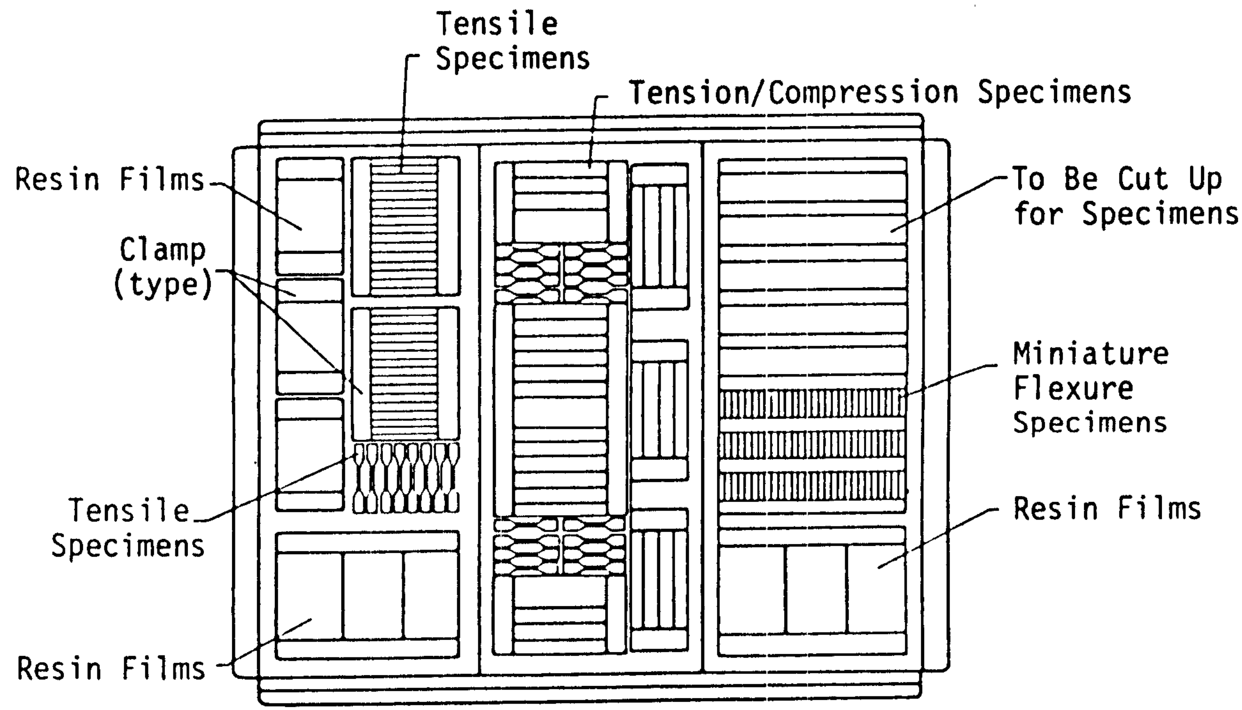


Panel



Tray

LDEF EXPERIMENT TRAY



Dimensions of Trays (after LDEF): Width - 34" (86.36 cm)
Length - 50" (127 cm)
Depth - 6" (15.24 cm)
(Weight - ~ 80 lbs typically)

EXPERIMENT TITLE: SPACECRAFT MATERIALS AND COATINGS TDMX 2011

PROPOSED FLIGHT DATE - 1992 (Est.) YEAR

OPERATIONAL DAYS REQUIRED - Continuous

MASS - 970 KG

VOLUME: Total of 3 parts

STORED: W 1m x L 10 x 5 x 5 x H 0.2m = 4 M^3

DEPLOYED: W 1m x L 10 x 5 x 5 x H 0.2m = 4 M^3

INTERNALLY ATTACHED No (YES/NO)
EXTERNALLY ATTACHED Yes (YES/NO)
FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) Solar, Velocity Vector, Wake

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 1 Hrs/Day 6 No. of days

OPERATIONS: ____ Hrs/Day ____ No. of days ____ Interval

SERVICING: 1 Hrs/Day 1 No. of days 90 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 2 Hrs/Day 6 No. of days

OPERATIONS: 0.1 Hrs/Day ____ No. of days Cont. Interval

SERVICING: 2 Hrs/Day 1 No. of days 90 Interval

POWER REQUIRED: Peak 0.65KW

AV. 0.46 KW AC or DC (circle one)

24 Hrs/Day Cont. No. of days

DATA RATE: 0.0113 Megabits/second

DATA STORAGE: ____ Gigabits

IN SITU TRACE CONTAMINANT ANALYSIS

Dr. Dana A. Brewer & Paul R. Yeager

OBJECTIVE

To develop an analysis/measurement capability for determining trace constituents in Space Station cabin environments so that the effectiveness of the Environmental Control and Life Support System (ECLSS) to maintain a safe environment for the crew can be assessed.

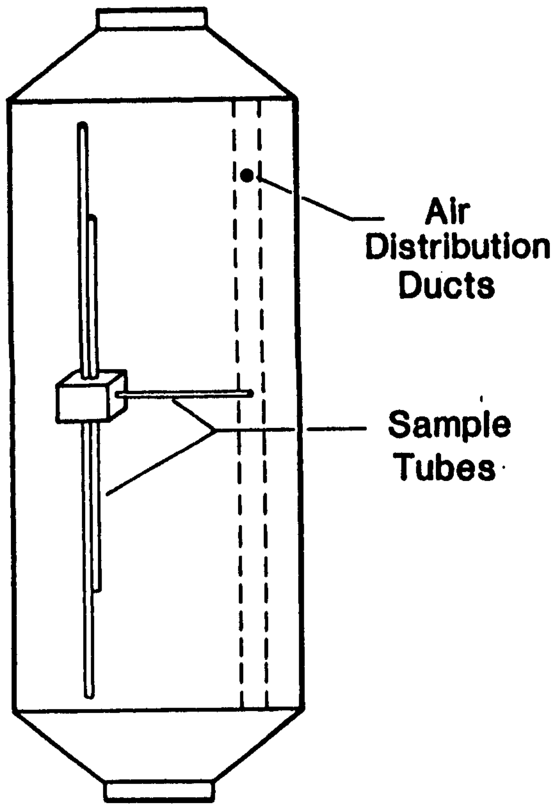
OMIT TO END

IN SITU TRACE CONTAMINANT ANALYSIS

Dr. Dana A. Brewer & Paul R. Yeager

DESCRIPTION

During missions of long duration, ineffective ECLSS operation and chemical reactions could degrade the Space Station cabin environment by producing toxic compounds. Consequently, it becomes mandatory that an analysis and measurement capability be developed to monitor these constituents. Therefore, a real-time, on-orbit measurement and analysis system for gas-phase atmospheric trace constituents will be developed and used to collect data on concentrations of trace constituents as a function of time. The effectiveness of the ECLSS and the chemical reactions, which are important in producing changes in atmospheric composition, will be identified using these data. In addition, these data will be used to validate an environmental analysis model for trace contaminants so that the impact of proposed future experiments on the cabin air environment can be assessed prior to the performance of the experiments. The validated model will be used as a tool in determining necessary growth requirements of the ECLSS for evolutionary Space Stations as well as a guideline for assisting in establishing new Spacecraft Maximum Allowable Concentrations (SMAC) of trace contaminants for missions of long duration.



Interior of One Lab Module

IN SITU TRACE CONTAMINANT ANALYSIS

Dr. Dana A. Brewer & Paul R. Yeager

EXPERIMENT DESIGN

- 5 Sampling Sites
- Real-time, on-orbit measurements of key hydrocarbons, NO, NO_2, O_3, aldehydes, and Freons
- Size distribution, gross number, and chemical analysis of particulates

DATA ANALYSIS

- Correlate in situ measurements with analysis of particulates and charcoal
- Use measurements to validate model
- Use validated model to assess both the impact of future experiments on cabin air and the growth requirements of the ECLSS for evolutionary Space Stations

EXPERIMENT TITLE: In Situ Trace Contaminant Analysis

PI: Dr. Dana A. Brewer and Paul R. Yeager

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - 90

MASS - 113.4 KG

VOLUME:

STORED	W	0.48	X L	0.52	X H	1.52	=	0.379 M^3
DEPLOYED	W	0.48	X L	0.52	X H	1.52	=	0.379 M^3

INTERNALLY ATTACHED YES

EXTERNALLY ATTACHED NO

FORMATION FLYING NO

ORIENTATION (inertial, solar, earth, other) N/A

EXTRA-VEHICULAR ACTIVITY REQUIRED: N/A

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	0	HRS/DAY		NO. OF DAYS		
OPERATIONS:	0	HRS/DAY		NO. OF DAYS		INTERVAL
SERVICING:	1	HRS/DAY	1	NO. OF DAYS	90	INTERVAL

POWER REQUIRED:

1.5 KW AC OR DC (circle one): EITHER

24 HRS/DAY 90 NO. OF DAYS

DATA TRANSMISSION RATE: 1 MEGABITS/SECOND FOR 10 SECONDS ONCE A DAY

DATA STORAGE: 0.1 GIGABITS FOR 24 HOURS OF DATA

ADVANCED SOLAR CONCENTRATOR MATERIALS AND COATINGS EXPERIMENT

EXPERIMENT OBJECTIVES

THE OVERALL OBJECTIVE OF THIS EXPERIMENT IS TO EVALUATE THE EFFECT OF THE COMBINED LEO ENVIRONMENT (U.V., ATOMIC OXYGEN, VACUUM, MICRO-METEORITES, ETC.), OVER AN EXTENDED PERIOD OF TIME (6 MO - 12 MO - 18 MO - 24 MO) ON A SELECTED NUMBER OF SCREENED CANDIDATE MATERIALS, FILMS AND COATINGS FOR ADVANCED TECHNOLOGY, HIGH ACCURACY, LIGHTWEIGHT CONCENTRATORS. THE EXPERIMENT IS TO BE SUN POINTED TO PROVIDE A REALISTIC OPERATIONAL ENVIRONMENT INCLUDING ΔT VARIATIONS IN SUN-SHADE CYCLES. AS PART OF THE OBJECTIVE, THE EXPERIMENT IS TO EVALUATE CANDIDATE, SUSBSTRATE MATERIALS, REFLECTIVE COATINGS AND PROTECTIVE FILMS AND MATERIALS. THIS EVALUATION IS TO ENCOMPASS ADVANCED CONCENTRATOR FABRICATION TECHNIQUES, INCLUDING BONDING, JOINING AND EDGE SEALING TECHNIQUES AND MATERIALS.

ADVANCED SOLAR CONCENTRATOR MATERIALS AND COATINGS EXPERIMENT

EXPERIMENT DESCRIPION

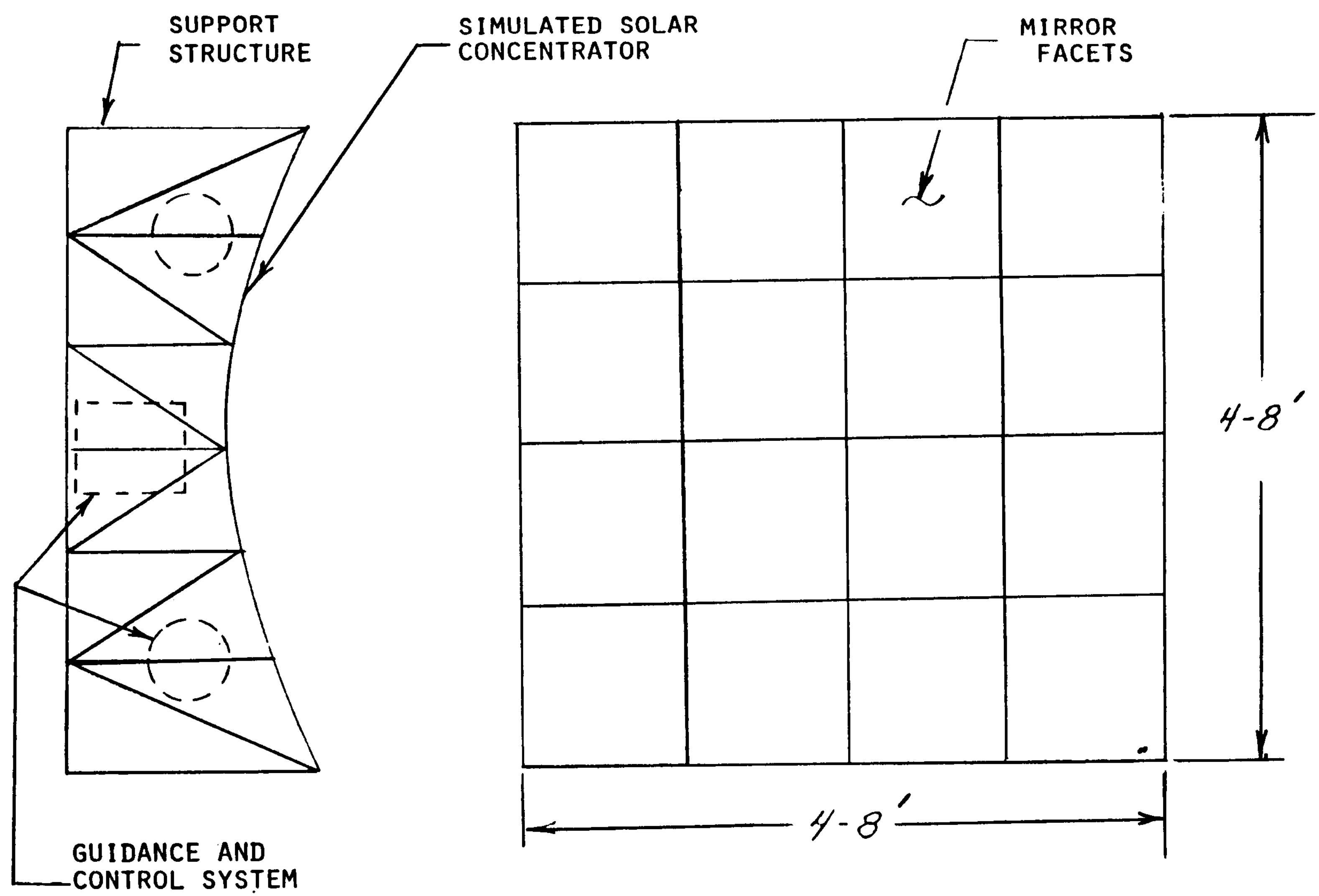
THE EXPERIMENT IS DESIGNED TO EVALUATE CANDIDATE MATERIALS AND COATINGS FOR ADVANCED TECHNOLOGY HIGH ACCURACY, LONG LIFE CONCENTRATORS IN THE LEO ENVIRONMENT FOR EXTENDED PERIODS (1/2-2 YRS). THE EXPERIMENT WOULD BE DEPLOYED FROM THE SHUTTLE AND WOULD BE MAINTAINED IN CONTINUOUS SUN-POINTED ATTITUDE, EXPOSING THE TEST SURFACES TO THE SUN-SHADE CYCLES AND RESULTING ΔT & THERMAL STRESSES. IN ADDITION TO TEST MIRROR SURFACES, THE EXPERIMENT WILL EVALUATE ADVANCED COATING TECHNIQUES, FABRICATION TECHNIQUES INCLUDING BONDING, JOINING, EDGE SEALING (ETC.). THIS CONSIDERS A COMBINED ENVIRONMENT INCLUDING ULTRA-VIOLET, ATOMIC OXYGEN, VACUUM, RADIATION, MICRO-METEOROIDS, SPACE CONTAMINANTS, TEMPERATURE, ETC.

THE EXPERIMENT TEST PACKAGE WOULD BE A COMPACT INTEGRATED ASSEMBLY INCORPORATING A SUPPORT STRUCTURE, A GUIDANCE AND CONTROL SYSTEM WITH POWER SUPPLY AND A SIMULATED CONCENTRATOR STRUCTURE FOR MOUNTING TEST ITEMS.

THE EXPERIMENT PACKAGE WOULD BE DESIGNED FOR MINIMUM WEIGHT, MINIMUM VOLUME AND COMPATIBILITY WITH THE SHUTTLE BAY. THE EXPERIMENT IS REUSABLE. AS PART OF THE DESIGN, SPECIFIC TEST ITEMS COULD BE REMOVED AND REPLACED IN ORBIT, OR THE ENTIRE PACKAGE COULD BE RETRIEVED AND RETURNED TO EARTH FOR EVALUATION. THIS WOULD BE A PASSIVE EXPERIMENT WITH A MINIMUM OF INSTRUMENTATION (E.G. TEMPERATURE MONITORING.)

THE SIMULATED CONCENTRATOR STRUCTURE WOULD BE DESIGNED TO ACCOMODATE LARGER SIZE TEST SURFACES (E.G. 12" X 12") WITH PROVISIONS FOR SMALLER SPECIMENS (E.G. 1" O.D.) SIZED FOR EVALUATION IN SPECIFIC INSTRUMENTS AFTER RETRIEVAL. THE EXPERIMENT WOULD BE A VALUABLE RESEARCH AND EVALUATION TEST TOOL FOR ADVANCED HIGH TECHNOLOGY SOLAR CONCENTRATORS.

ADVANCED SOLAR CONCENTRATOR MATERIALS AND COATINGS EXPERIMENT



EXPERIMENT TITLE: ADVANCED SOLAR CONCENTRATOR MATERIALS AND COATING EXPERIMENT

PROPOSED FLIGHT DATE - TBD YEAR

OPERATIONAL DAYS REQUIRED - 180-720

MASS - TBD KG

VOLUME: TBD

STORED: W — x L — x H — = — M^3

DEPLOYED: W — x L — x H — = — M^3

INTERNALLY ATTACHED ____ (~~YES/NO~~)
EXTERNALLY ATTACHED ____ (~~YES/NO~~)
FORMATION FLYING ____ (~~YES/NO~~)

ORIENTATION (inertial, solar, earth, other) SOLAR

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: — Hrs/Day — No. of days

OPERATIONS: — Hrs/Day — No. of days — Interval

SERVICING: — Hrs/Day — No. of days — Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: — Hrs/Day — No. of days

OPERATIONS: — Hrs/Day — No. of days — Interval

SERVICING: — Hrs/Day — No. of days — Interval

POWER REQUIRED:

— KW AC or DC (circle one)

— Hrs/Day — No. of days

DATA RATE: — Megabits/second

DATA STORAGE: — Gigabits

JPL

MICROELECTRONICS DATA SYSTEM EXPERIMENT

A. Johnston

OCTOBER 8-10, 1985

IN-SPACE RESEARCH, TECHNOLOGY AND ENGINEERING WORKSHOP

• EXPERIMENT OBJECTIVES

- FACILITATE APPLICATION OF TWO NEW TECHNOLOGIES, MICRO-ELECTRONICS AND OPTOELECTRONICS, IN SPACE BY ENABLING REALISTIC TESTING OF COMPONENTS OR KEY SYSTEM ELEMENTS TO BE MADE EARLY IN THEIR DEVELOPMENT

- ESTABLISH A FREQUENT OPPORTUNITY TO TEST AND EVALUATE ADVANCED MICROELECTRONIC COMPONENTS OR SUBSYSTEMS IN THE SPACE ENVIRONMENT

- PROVIDE A FRAMEWORK WHICH IS ACCESSIBLE TO A BROAD GROUP OF EXPERIMENTS TO MAKE EXPERIMENTS COST EFFECTIVE, READILY RE-FLYABLE

ARJ
OCT/85

JPL

EXPERIMENT DESCRIPTION

- THE EXPERIMENT WOULD CONSIST OF TWO MAIN PARTS, A SUPPORT TRAY, AND A NUMBER OF DIFFERENT EXPERIMENT MODULES. THEIR FUNCTIONS ARE DESCRIBED AS FOLLOWS
  - EXPERIMENT MODULES
    - DEVELOPED AROUND A KEY DEVICE OR TECHNOLOGY TO BE TESTED
    - PROVIDED BY INDIVIDUAL PI's
    - MODULES WILL BE EASILY REPLACEABLE, AND REFLYABLE
    - DESIGNED FOR PLUG-IN REPLACEMENT IN SUPPORT TRAY
    - COUPLED TO ONGOING R&D IN TECHNOLOGY AREA
    - COULD BE A SPACE SCIENCE EXPERIMENT
    - MUST CONFORM TO PRE-DEFINED AND TESTABLE INTERFACE WITH SUPPORT TRAY
  - SUPPORT TRAY
    - PROVIDES COMMON SUPPORT FUNCTIONS, SUCH AS DATA FORMATTING, POWER CONDITIONING, AND MECHANICAL MOUNT FOR EXPERIMENT MODULES
    - REMAINS ON SPACE STATION THROUGHOUT PROGRAM
    - SIZE $\approx$ 1m x 1.5m x 0.5 in.

ARJ
OCT/85

JPL

EXPERIMENT PHILOSOPHY

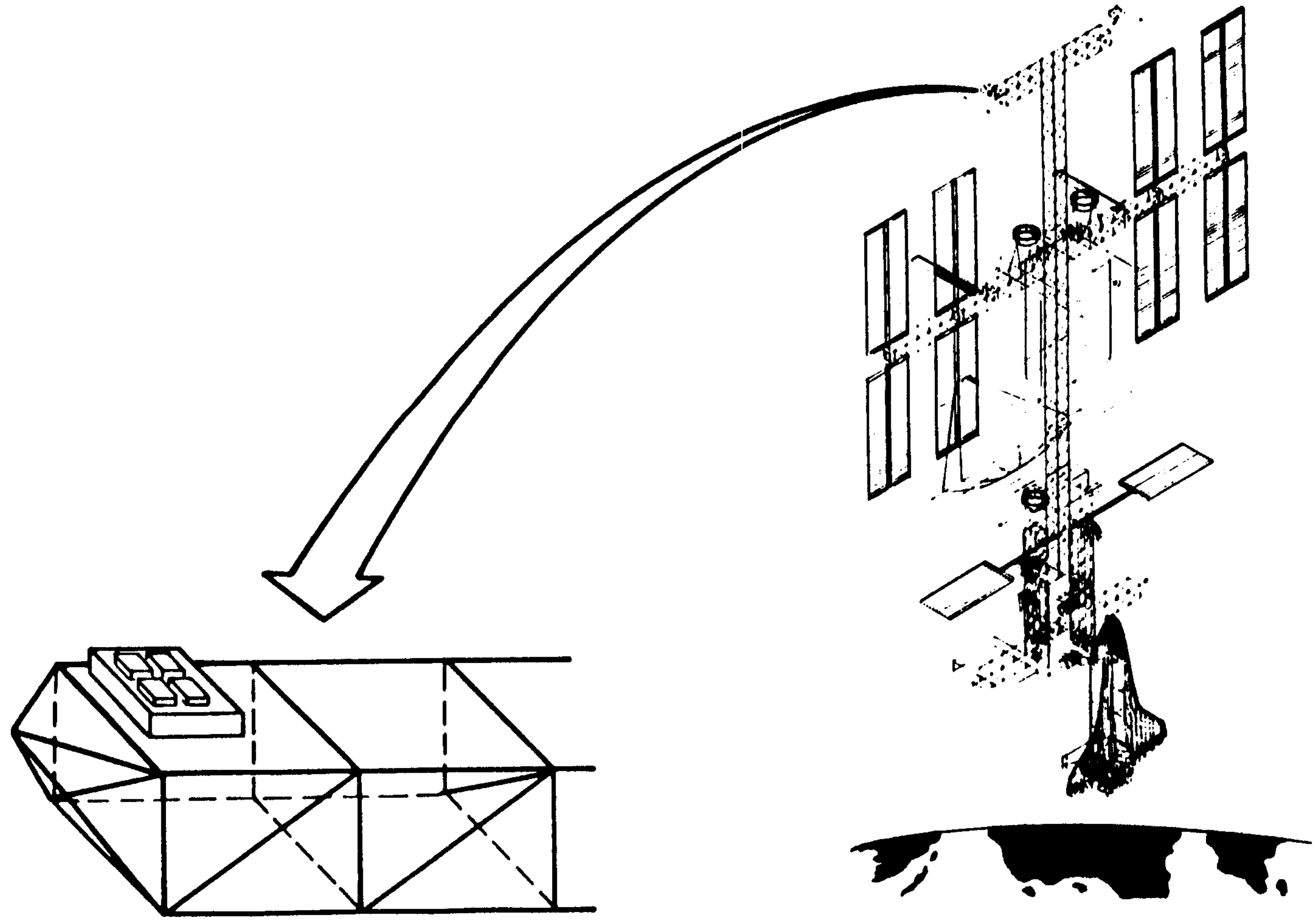
- CREATE A PROGRAM TO IMPLEMENT THE SUPPORT FUNCTION
  - DEVELOP SUPPORT TRAY HARDWARE
  - PROVIDE PI SUPPORT AND CONTINUITY
  - ADVERTISE OPPORTUNITY TO PI COMMUNITY
- EXPERIMENT MODULE DEVELOPMENT SHOULD PROVIDE AN OPPORTUNITY TO EVALUATE CURRENTLY IMMATURE TECHNOLOGY
  - MAKE IT POSSIBLE TO FLY A BREADBOARD
  - SHORT DEVELOPMENT TIME FOR MODULE ITSELF
  - COST SHOULD BE 100's OF K$ RATHER THAN FEW M$
  - MINIMUM RESTRICTIONS ON DESIGN EXCEPT FOR FIXED INTERFACE WITH SUPPORT TRAY
- SUPPORT ELECTRONICS ALSO MODULAR TO ALLOW FOR UPGRADING IF DESIRED DURING A MULTIYEAR MISSION

ARJ
OCT/85

JPL

TDMX 2441: MICROELECTRONICS DATA SYSTEM EXPERIMENT DEFINITION STUDY

(VOLUME 12)



ACCOMMODATION REQUIREMENTS

EXPERIMENT TITLE: Microelectronics Data System Experiment

PRINCIPAL INVSTIGATOR(S): A. Johnston, et al

ADDRESS: Jet Propulsion Laboratory - 4800 Oak Grove Dr., Pasadena, CA 91109

PROPOSED FLIGHT DATE 1992 to 2001 YEAR(S)

OPERATIONAL DAYS REQUIRED 365 (PER YEAR)

MASS 100 KG

VOLUME:

STORED	W	1.0	x L	2.0	x H	0.5	=	1.0	M3
DEPLOYED	W	1.0	x L	2.0	x H	0.5	=	1.0	M3

INTERNALLY ATTACHED No (YES/NO)
EXTERNALLY ATTACHED Yes (YES/NO)
FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) Anti-earth

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	2	Hrs/Day	2	No. of days.		
OPERATIONS:	0	Hrs/Day	0	No. of days.	---	Interval
SERVICING:	1/2	Hrs/Day	1	No. of days.	yearly	Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	2	Hrs/Day	2	No. of days.		
OPERATIONS:	1	Hrs/Day	1	No. of days.	weekly	Interval
SERVICING:	1	Hrs/Day	1	No. of days.	yearly	Interval

POWER REQUIRED:

0.25 KW AC or DC (circle one)

24 Hrs/Day continuous No. of days

DATA RATE: 1 Megabits/second

DATA STORAGE: 0.1 Gigabits

TRANSIENT UPSET PHENOMENA IN VLSI DEVICES
TDMX 2442

Investigators:

Dr. Gerald M. Masson
The Johns-Hopkins University

Felix L. Pitts
NASA Langley Research Center

OBJECTIVE:

Develop a data base from in situ experiments which will contribute to understanding, characterization, and circumvention of alpha particle and cosmic ray induced single event upsets of very large scale integrated (VLSI) circuits in space applications. In digital systems for space applications, desirable circuit features such as high speed, low power, and high bit/chip density result in increased susceptibility to particle induced single event upset. Since neither shielding or hardening will alleviate this problem completely, there is a need to understand the nature of system upsets induced by high energy particles in the complex devices which could be used to enhance space applications.

DESCRIPTION:

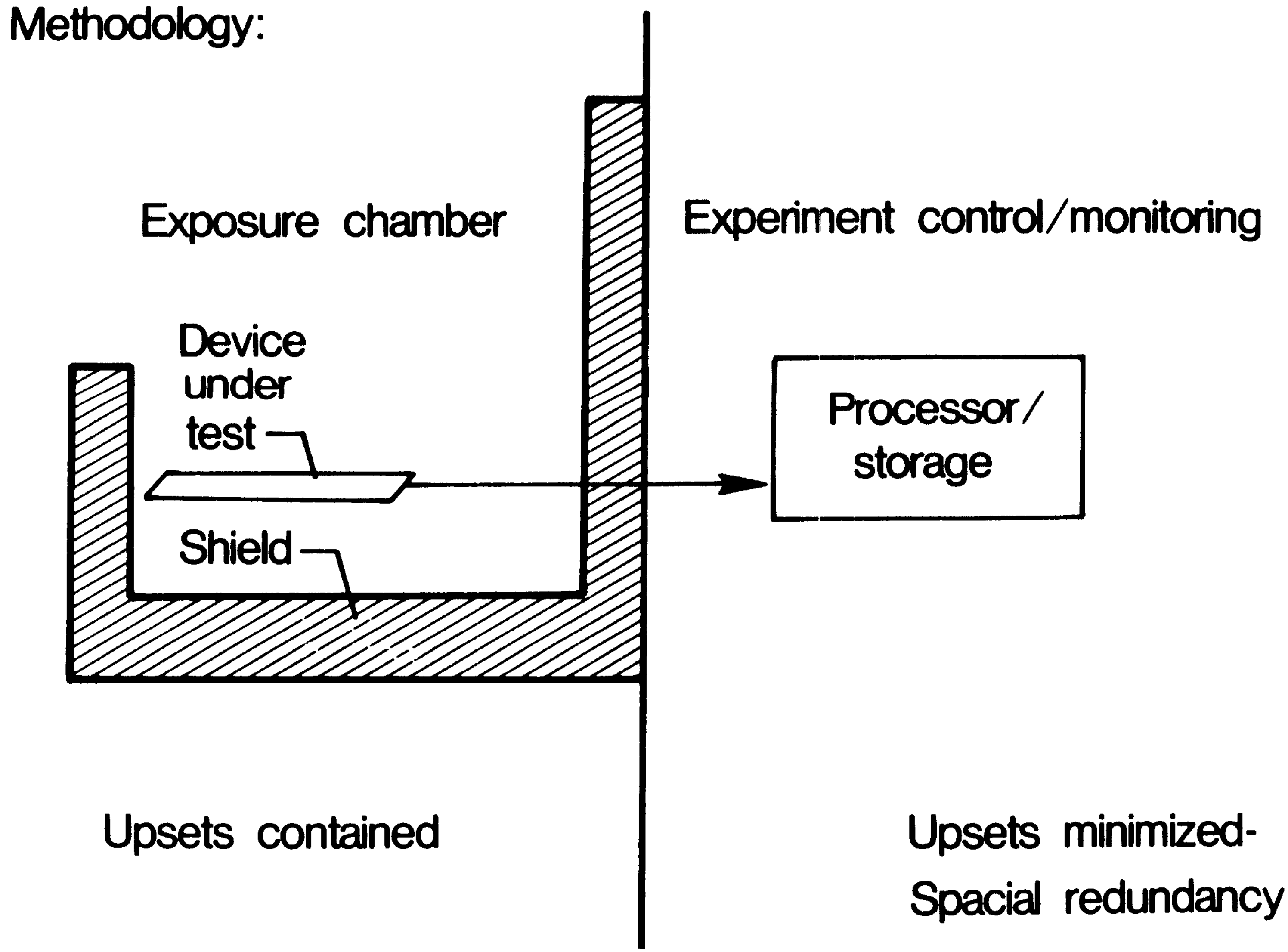
The experiment consists of three components: the unit under test (UUT), the experiment control and monitoring (ECM) computer, and equipment to measure the radiation environment. The VLSI integrated circuits used in the UUT will be specially fabricated units such as random access memories, processors, etc., which will permit accurate detection and characterization of upsets. The output signals generated by the UUT while performing a generic program will be monitored and checked by the ECM to accomplish "instrumentation" of system upsets by recording the values of the monitored signal lines from the UUT at the time of upset. The ECM will interface with the Space Station data and communication bus for data transmission to the ground. The radiation environment will be measured to develop statistical data for establishing the cause-effect relationship between the environment and the single event upsets. The UUT would be minimally shielded to deliberately expose it to a worst case radiation environment for the given Space Station orbit. The ECM would require maximum shielding and incorporate a high degree of fault tolerance through spacial redundancy so as to be minimally affected by cosmic radiation. This redundancy will decrease the probability of undetected ECM faults and, therefore, provide experiment data integrity. Some analysis of the events monitored will be performed onboard in the ECM computer, thus reducing the amount of data which will require storage or transmission to the ground.

TRANSIENT UPSET IN VERY LARGE SCALE INTEGRATED CIRCUIT DEVICES

- Single event upset:
  - Phenomena caused by cosmic particle interaction with integrated devices
  - Predicted 1962, observed in RAMS in 1974
  - Experiment on CRRES satellite 1987 (AFGL)
- Phenomenology
  - Cosmic particle ionizes semiconductor material
  - Charge collection near depletion regions (pico coulombs)
  - Manifest as state changes in bi-stable devices
- Desirable VHSIC circuit features increase susceptibility
  - High speed
  - Low power
  - High bit/chip density

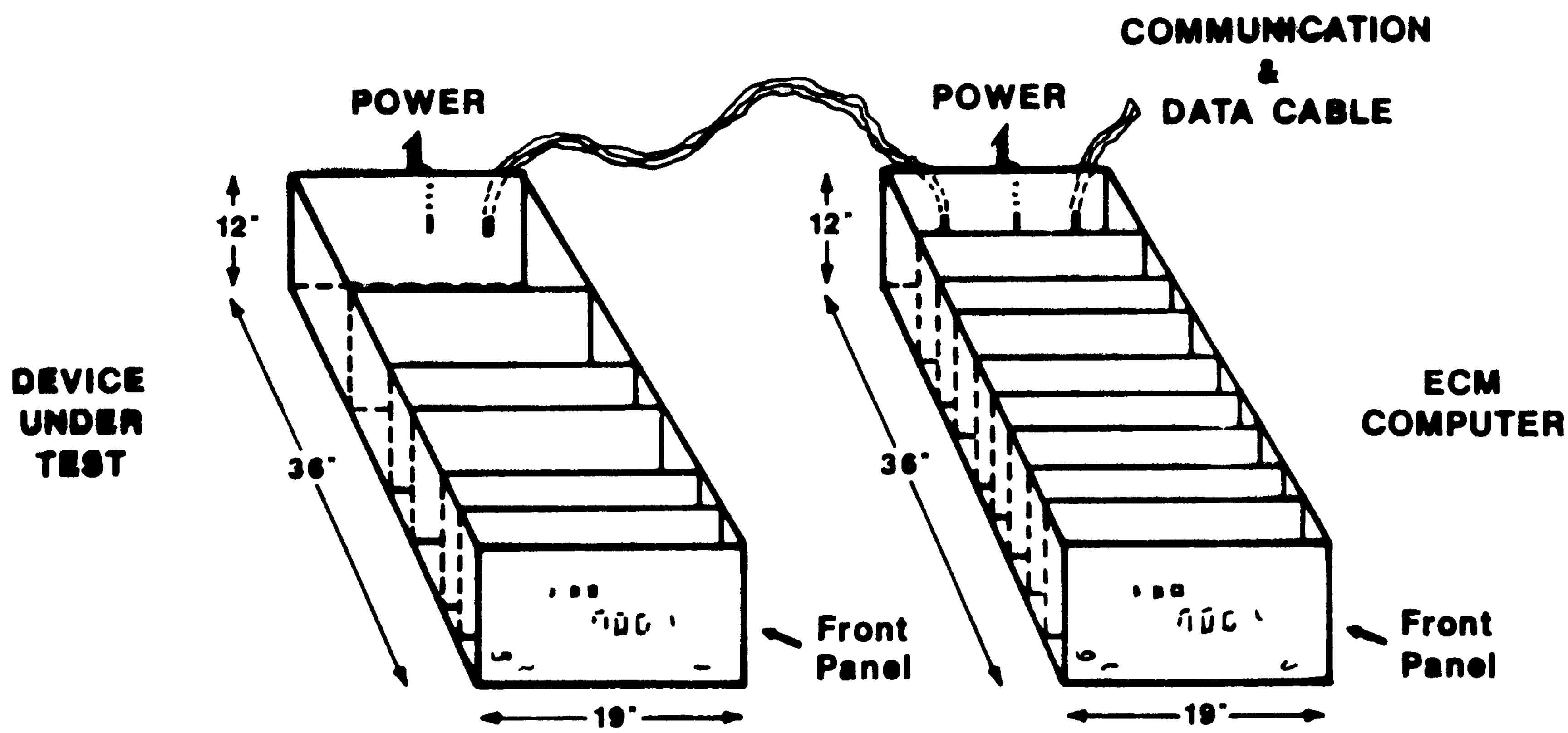
TRANSIENT UPSET IN VERY LARGE SCALE INTEGRATED CIRCUIT DEVICES

Methodology:



TRANSIENT UPSET IN VERY LARGE SCALE INTEGRATED CIRCUIT DEVICES

EXPERIMENT CONFIGURATION



EXPERIMENT TITLE: Transient Upset Phenomena in VLSI Devices

PROPOSED FLIGHT DATE - 1992-1995 YEAR

OPERATIONAL DAYS REQUIRED - Continuous

MASS - 100 KG

VOLUME:

STORED: W ______ x L ______ x H ______ = 0.3 M^3

DEPLOYED: W 1 x L 1 x H 0.30 = 0.3 M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED no (YES/NO)
FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) Any

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 3/4 Hrs/Day 1 No. of days

OPERATIONS: 1/4 Hrs/Day 1/4 No. of days 60 Interval

SERVICING: 1 Hrs/Day 1 No. of days 180 Interval

POWER REQUIRED:

0.1 KW AC or DC (circle one)

Continuous Hrs/Day ______ No. of days

DATA RATE: * Megabits/second

DATA STORAGE: 0 Gigabits

*Approximately 1 Megabit per month.

TDMX 2443 -- VHSIC FAULT TOLERANT PROCESSOR

CONTACT: H. F. BENZ, MAIL STOP 473
NASA LARC (804)865-3535

OBJECTIVE:

THE MISSION OBJECTIVE IS TO ACQUIRE REALISTIC DATA ON SINGLE EVENT UPSET DETECTION AND RECOVERY IN A SELF-TESTABLE GENERAL PURPOSE COMPUTER CONFIGURATION WHICH USES 1.25 MICROMETER VERY HIGH SPEED INTEGRATED CIRCUIT (VHSIC) TECHNOLOGY. THE DATA COLLECTED BY THIS EXPERIMENT WILL RESULT IN A THOROUGH UNDERSTANDING OF THE RELIABILITY AND FAULT TOLERANCE OF SUCH A SYSTEM IN A REALISTIC OPERATING ENVIRONMENT FOR OTHER SPACE APPLICATIONS.

SEVERAL ADVANCED SYSTEM-LEVEL TECHNOLOGIES WILL BE USED TO IMPLEMENT RECOVERABILITY FROM DEVICE UPSETS INCLUDING REDUNDANT COMPUTATIONS, BUILT-IN TEST, SYSTEM RECONFIGURATION.

DESCRIPTION:

REFER TO FIGURES 1 AND 2 FOR A BLOCK DIAGRAM AND SKETCH OF THIS EXPERIMENT. THE EXPERIMENT PACKAGE WILL CONSIST OF A FAULT-TOLERANT GENERAL PURPOSE COMPUTER DESIGNED AROUND THE VHSIC PHASE I CHIP SET, PROGRAMMED FOR REDUNDANT TASKS WHICH SIMULATE MISSION-CRITICAL FUNCTIONS AS WELL AS FAULT MONITORING ACTIVITIES. THE SYSTEM WILL RECORD FAULT DETECTION, TEST, AND ISOLATION SEQUENCES, AS WELL AS THE OCCURENCE OF HARD FAULTS AND THE RESULTING RECONFIGURATION ACTIVITIES.

THE PROCESSOR WILL BE IMPLEMENTED WITH AN ARCHITECTURE THAT IS RESISTANT TO SINGLE EVENT UPSETS, AND WILL UTILIZE THE HIGHEST CHIP DENSITY COMPONENT-LEVEL TECHNOLOGY AVAILABLE. IT IS ANTICIPATED THAT AT THE START OF THE EXPERIMENT THIS DENSITY WILL BE REPRESENTED BY THE VHSIC PHASE I 1.25 MICROMETER TECHNOLOGY, WHILE DURING THE LIFE SPAN OF THE EXPERIMENT THE VHSIC PHASE II SUB-MICROMETER TECHNOLOGY WILL BECOME AVAILABLE. PLANNED TECHNOLOGY UPGRADES WILL BE MADE IN THE EXPERIMENT PACKAGE THROUGH THE USE OF FUNCTIONAL MODULARITY AT THE PROCESSOR LEVEL, AS WELL AS SOFTWARE MODULARITY THROUGH THE USE OF THE ADA PROGRAMMING LANGUAGE.

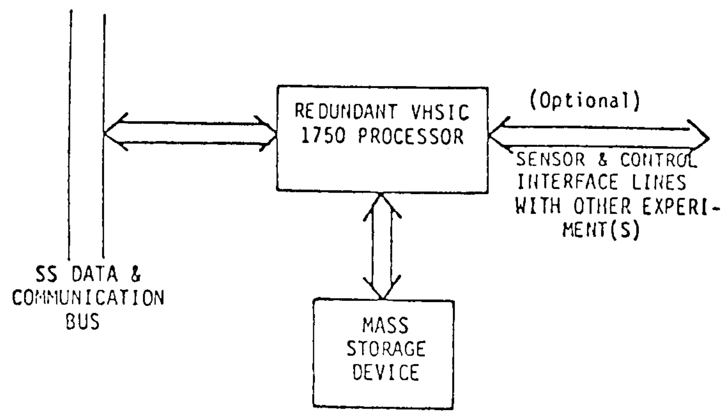


Figure 1. Block Diagram of TDM Experiment 2443, VHSIC Fault-tolerant Processor.

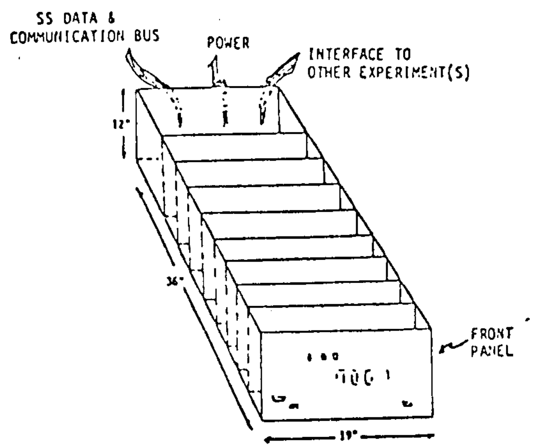


Figure 2. Configuration Sketch of TDM Experiment 2443, VHSIC Fault-tolerant Processor.

EXPERIMENT TITLE: VHSIC Fault Tolerant Processor

PROPOSED FLIGHT DATE - 92-94 YEAR

OPERATIONAL DAYS REQUIRED - 565

MASS - 100 KG

VOLUME:

STORED: W ______ x L ______ x H ______ = 0.15 M^3

DEPLOYED: W ______ x L ______ x H ______ = 0.15 M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED no (YES/NO)
FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) Fixed to Station

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0.75 Hrs/Day 1 No. of days

OPERATIONS: 24 Hrs/Day 565 No. of days cont Interval

SERVICING: 2.5 Hrs/Day 1 No. of days 1 yr Interval

POWER REQUIRED:

1 KW AC or DC (circle one)

24 Hrs/Day 525 No. of days

DATA RATE: 0.000 Megabits/second (10 KBps, 0.25 hr per day)

DATA STORAGE: 0.000 Gigabits (1MB)

40 – 105 GHz PROPAGATION EXPERIMENT

G. Anzic

OBJECTIVE

ESTABLISH DATA BASE FOR ATMOSPHERIC PROPAGATION OF 40 TO 105 GHz MILLIMETER WAVE SIGNALS BY UTILIZING THE SPACE STATION AS SIGNAL SOURCE AND A NUMBER OF GROUND STATIONS AS DATA COLLECTION POINTS. THE FOLLOWING FREQUENCIES WILL BE OF INTEREST:

SERVICE	FREQUENCY	
	DOWN LINK	*UP LINK*
FIXED	40.0–41.0	50.0–51.0
	102.0–105.0	92.0–95.0
BROADCAST	41.0–43.0	
	84.0–86.0	
SATELLITE MOBILE	43.0–48.0	
	66.0–71.0	
	95.0–101.0	

40–105 GHz PROPAGATION EXPERIMENT

APPROACH

- PERFORM TECHNOLOGY ASSESSMENT STUDY TO AID IN EXPERIMENT DESIGN (LINKS, REQUIREMENTS, ETC.)
- DEVELOP SPACE SEGMENT PACKAGE (TRANSMITTERS, ANTENNAS, ETC.)
- DEVELOP GROUND STATIONS (PLL RECEIVERS, TRACKING ANTENNAS, ETC.)
- STANDARDIZE DATA COLLECTION SYSTEM FORMATS
- PROVIDE EXPERIMENTERS (NUMBER, LOCATION, ETC.)
- PROCESS DATA

40-105 GHz PROPAGATION EXPERIMENT

EXPERIMENT DESCRIPTION

The 40-105 gigahertz propagation experiment will consist of three main segments. The space segment, the data collections segment (experimenters, ground stations) and the data processing segment.

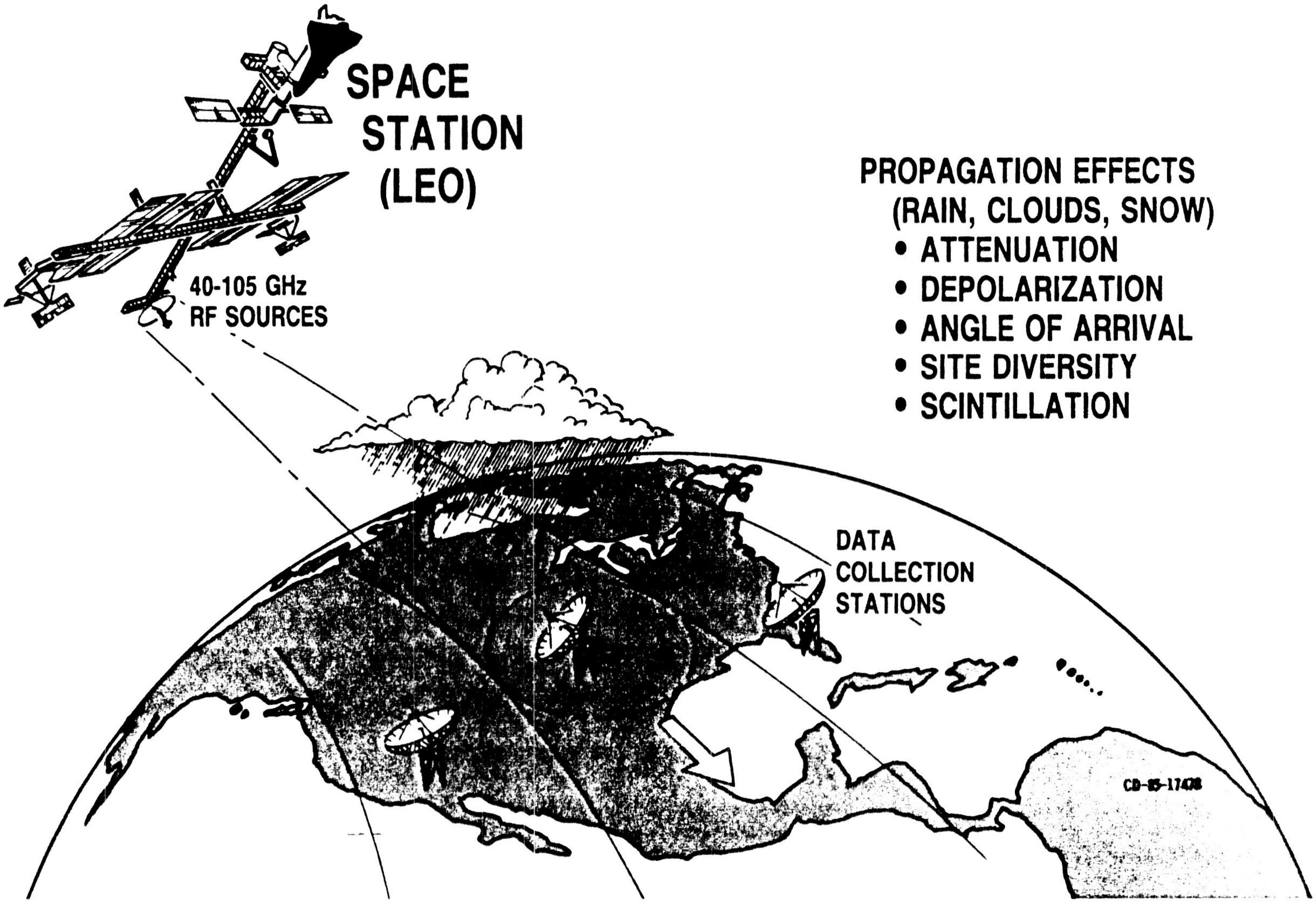
Multiple radiofrequency sources with steerable antennas, power supply and control circuitry are envisioned to comprose the space segment package of the experiment.

The data collection segment will consist of a number of suitably located ground stations capable of receiving and recording the signal parameters from the space station after they have been affected by the earth's atmosphere. Due to relatively large signal margin (referenced to clear sky) requirements at these frequencies antenna steering will be required on both the space and ground segments of the link. Automated antenna tracking between the experiment participants and the space station orbit passes (estimated 15 minutes per pass)will be required.

The data processing segment of the experiment will consist of the collection and processing of the standard format tapes produced by the experimenters (ground stations). Reduced propagation data will be distributed to better define the future links in the frequencies of interest.

Godfrey Anzic
NASA Lewis Research Center
21000 Brookpark Road
M. S. 54-5
Cleveland, OH 44135

40-105 GHz PROPAGATION EXPERIMENTS



PROPAGATION EFFECTS (RAIN, CLOUDS, SNOW)
- ATTENUATION
- DEPOLARIZATION
- ANGLE OF ARRIVAL
- SITE DIVERSITY
- SCINTILLATION

EXPERIMENT TITLE: 40-105 GHz Propagation Experiment

PROPOSED FLIGHT DATE - 1994 YEAR

OPERATIONAL DAYS REQUIRED - 3 years (continuous)

MASS - 400 KG

VOLUME:

STORED: W 1.5 x L 1 x H 1 = 1.5 M^3

DEPLOYED: W 2.5 x L 1 x H 0.5 = 1.75 M^3

INTERNALLY ATTACHED no (YES/NO)
EXTERNALLY ATTACHED yes (YES/NO)
FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) earth

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 10 Hrs/Day 1 No. of days

OPERATIONS: 0 Hrs/Day 0 No. of days 0 Interval

SERVICING: 5 Hrs/Day 1 No. of days 6 mo. Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0 Hrs/Day 0 No. of days

OPERATIONS: 0 Hrs/Day 0 No. of days 0 Interval

SERVICING: 0 Hrs/Day 0 No. of days 0 Interval

POWER REQUIRED:

0.5 KW AC or DC (circle one)

24 Hrs/Day 1000 No. of days

DATA RATE: 0.1 Megabits/second

DATA STORAGE: 0 Gigabits

Godfrey Anzic
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21000 Brookpark Road
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Cleveland, OH 44135

National Aeronautics and
Space Administration

Lewis Research Center

SPACE EXPERIMENTS OFFICE

NASA

COLLISIONFREE PLASMA EXPERIMENTS USING THE
IONOSPHERE AS A LABORATORY FOR FUNDAMENTAL TECHNOLOGY-ORIENTED RESEARCH
SUPPORTING THE DEVELOPMENT OF FUTURE HIGH ENERGY SYSTEMS

LYNN M. ANDERSON

NASA LEWIS RESEARCH CENTER

OAST IN-SPACE RESEARCH, TECHNOLOGY, AND ENGINEERING WORKSHOP

WILLIAMSBURG, VA., OCTOBER 8-11, 1985

SPACE APPLICATIONS

TO CONTRIBUTE TO U.S. TECHNICAL LEADERSHIP AND SECURITY

- SPACE VANTAGE POINT .... • COMMUNICATION SATELLITES
  - • REMOTE SENSING
- MICROGRAVITY .... • MATERIALS SCIENCE/PROCESSING
  - • SPACE HABITAT
- ► IMPERFECT VACUUM .... • NEW TECHNOLOGY
  - RAREFIED GAS
  - ► COLLISIONFREE PLASMA
  - OTV, REENTRY, AEROASSIST, TAV
  - BEAMS, LASERS, PLASMA PROPULSION, OTV, STRATEGIC DEFENSE, "SATELLITES"
- FUNDAMENTAL RESEARCH
  - SHUTTLE AS A RESEARCH VEHICLE
  - ► IONOSPHERE AS A LABORATORY

National Aeronautics and Space Administration
Lewis Research Center

SPACE EXPERIMENTS OFFICE

NASA

COLLISIONFREE LAB IN LOW EARTH ORBIT

OBJECTIVE: TO EXPLOIT THE IMPERFECT VACUUM OF LOW EARTH ORBIT AS A COLLISIONFREE LABORATORY FOR FUNDAMENTAL TECHNOLOGY-ORIENTED RESEARCH ON PLASMAS, THE HIGH ENERGY STATE OF MATTER

JUSTIFICATION: UNIQUE PROPERTIES, POTENTIAL TECHNOLOGY BENEFITS

- ▶ COLLISIONFREE
  - KILOMETER MEANFREE PATH IN LEO
  - ▶ CANNOT DUPLICATE ON EARTH
- ANOMALOUS
  - TRANSPORT PROPERTIES CHANGE WITH WAVE SPECTRUM
  - TUNABLE VISCOSITY, RESISTANCE
- TURBULENT
  - MANY COMPETING WAVES
  - MULTIDISCIPLINARY ADVANCES
- ▶ COHERENT
  - ▶ LEVERAGED ACCELERATION, HEATING
  - NEW TECHNOLOGY

PROBLEMS IN SEARCH OF A COLLISIONFREE LAB

THERE ARE PREDICTABLE ROADBLOCKS TO THE DEVELOPMENT OF FUTURE TECHNOLOGY INVOLVING HIGH ENERGY SYSTEMS -

---

- ▶ SCIENTISTS AND ENGINEERS LACK FAMILIARITY WITH COLLISIONFREE FLUIDS.
- ANALYSIS IS INHERENTLY DIFFICULT BECAUSE TRANSPORT PROPERTIES AND DYNAMICS ARE DETERMINED BY THE SEQUENCE OF COMPETING INSTABILITIES AND THEIR NONLINEAR INTERACTIONS, BOTH RANDOM AND COHERENT
- ▶ TURBULENCE MODELS HAVE NOT BEEN TESTED AGAINST CONTROLLED EXPERIMENTS WITH TIME RESOLVED DIAGNOSTICS
- SCALING LAWS ARE NOT GENERALLY AVAILABLE TO GUIDE ENGINEERS
- COMPUTER SIMULATIONS OFTEN REQUIRE TEN HOURS OF CRAY TIME
- ▶ COLLISIONFREE LABS ARE GENERALLY FUSION OR WEAPON SYSTEMS
- ▶ DIAGNOSTICS ARE EXCEPTIONALLY DIFFICULT DUE TO EXTREME TEMPERATURES AND SHORT CONFINEMENT TIMES
- ▶ INTERPRETATION IS DIFFICULT DUE TO COMPLEX GEOMETRIES
- TECHNOLOGY DEVELOPMENT IS SLOW AND COSTLY

THE IONOSPHERE AS A LABORATORY

ASSETS

- LARGE VOLUME
- COLLISIONFREE MAGNETIZED PLASMA
- HOMOGENEOUS STABLE UNBOUNDED SYSTEM
- VARIABLE PARAMETERS

DEFICIENCIES

- MOVING VEHICLE
- PERTURBED CONTAMINATED LOCAL ENVIRONMENT
- LACK OF SPACE-TIME DIAGNOSTICS
- INADEQUATE DATA FROM LOCAL PROBES

REQUIREMENTS

- REMOTE EXPERIMENTAL CAPABILITY
  - KNOWLEDGE OF ORBITER FOOTPRINT
  - ELECTRON OR WAVE OPTICS
  - TRANSIENT STRUCTURES FOR GUIDING
- LARGE-AREA IMAGING AND TIME-RESOLVED DIAGNOSTICS
- GENTLE CONTROLLED PERTURBATIONS
- PROGRAM OF QUANTITATIVE THEORETICAL PREDICTIONS AND DEFINITIVE EXPERIMENTS TO SYSTEMMATICALLY ADVANCE THE DISCIPLINE BASE

ACCOMODATION REQUIREMENTS

EXPERIMENT TITLE: Collisionfree Lab in Low Earth Orbit

PROPOSED FLIGHT DATE - 1995 YEAR

OPERATIONAL DAYS REQUIRED - 1-10

MASS - TBD KG

VOLUME:

STORED W TBD x L ______ x H ______ = ______ M3

DEPLOYED W TBD x L ______ x H ______ = ______ M3

INTERNALLY ATTACHED Yes (YES/NO)
EXTERNALLY ATTCHED No (YES/NO)
FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) Controlled variation wrt Geomagnetic

EXTRA-VEHICULAR ACTIVITY REQUIRED: No

______ Hrs/Day ______ No. of days.

INTRA-VEHICULAR ACTIVITY REQUIRED: Yes

TBD Hrs/Day ______ No. of days

POWER REQUIRED:

TBD KW AC or DC (circle one)

TBD Hrs/Day TBD No. of days

DATA RATE: TBD Megabits/second

DATA STORAGE: TBD Gigabits

ELECTROPHORESIS IN SPACE

EXPERIMENT OBJECTIVE:

TO DETERMINE THE FEASIBILITY OF UTILIZING THE MICROGRAVITY ENVIRONMENT FOR IMPROVED METHODS OF SEPARATING AND PURIFYING BIOLOGICAL PRODUCTS (PROTEINS, HORMONES, CELLS) AND OTHER MATERIALS THROUGH THE USE OF ELECTROPHORESIS TECHNIQUES

DESCRIPTION:

THIS EXPERIMENT INVOLVES THE DEMONSTRATION AND ANALYSIS OF ELECTROPHORESIS TECHNIQUES CARRIED OUT IN SPACE. INITIAL EXPERIMENTS HAVE BEEN ACCOMPLISHED ON THE SPACE SHUTTLE, WITH ENCOURAGING RESULTS. THE PROCESS CONSISTS OF INJECTING THE MIXTURE TO BE SEPARATED INTO A CONFINING "CELL" ALONG WHICH THE MATERIAL WILL FLOW. AN ELECTRICAL FIELD ALIGNED ACROSS THIS "CELL" CAUSES THE COMPONENTS OF THE MIXTURE TO TAKE SLIGHTLY DIFFERENT PATHS, AND THUS TO SEPARATE, ACCORDING TO THEIR ELECTROPHORETIC MOBILITY. INDIVIDUAL OUTLET PIPES COLLECT THE SEPARATED COMPONENTS. IN SPACE THIS PROCESS MAY BE SCALED UP BEYOND EARTH BASED SYSTEMS. THE ABSENCE OF SEDIMENTATION EFFECTS AND THERMAL CONVECTION EFFECTS THAT ARE PARASITIC TO THE PROCESS SHOULD ALLOW GREATER YIELDS AND PURITY OF SEPARATED MIXTURE COMPONENTS.

EXPERIMENT TITLE: Electrophoresis in Space

PROPOSED FLIGHT DATE - present + **YEAR**

OPERATIONAL DAYS REQUIRED - 8

MASS - 150 **KG**

VOLUME:

STORED: W 1 x L ~~0.5~~ 1.0 x H 2 = ~~1.0~~ 2.0 M^3

DEPLOYED: W " x L " x H " = " M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED no (YES/NO)
FORMATION FLYING ? (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A, 10^{-6} G

EXTRA-VEHICULAR ACTIVITY REQUIRED: N/A

SET-UP:		Hrs/Day		No. of days		
OPERATIONS:		Hrs/Day		No. of days		Interval
SERVICING:		Hrs/Day		No. of days		Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	8	Hrs/Day	1	No. of days		
OPERATIONS:	4	Hrs/Day	8	No. of days	1 h	Interval
SERVICING:	2	Hrs/Day	8	No. of days	4 h	Interval

POWER REQUIRED: ~~.35~~ 0.5 **KW** AC or DC (circle one)

24 **Hrs/Day** 8 **No. of days**

DATA RATE: .004 **Megabits/second**

DATA STORAGE: 10^{-2} **Gigabits**

GROWTH OF THIN SINGLE CRYSTAL FILMS OF RHODIUM

Jag J. Singh
NASA Langley Research Center
Hampton, Virginia

and

Jon J. Spijkerman
Ranger Scientific Company
Burleson, Texas

EXPERIMENTAL OBJECTIVES

- Develop techniques for the growth of thin single crystal films of Rhodium by molecular beam epitaxial growth process in the microgravity environment onboard the space station

- Transmute selected Rhodium films into palladium by Rh^{103} (p, n) Pd^{103} reaction in a terrestial laboratory (VDG/Cyclotron Lab)

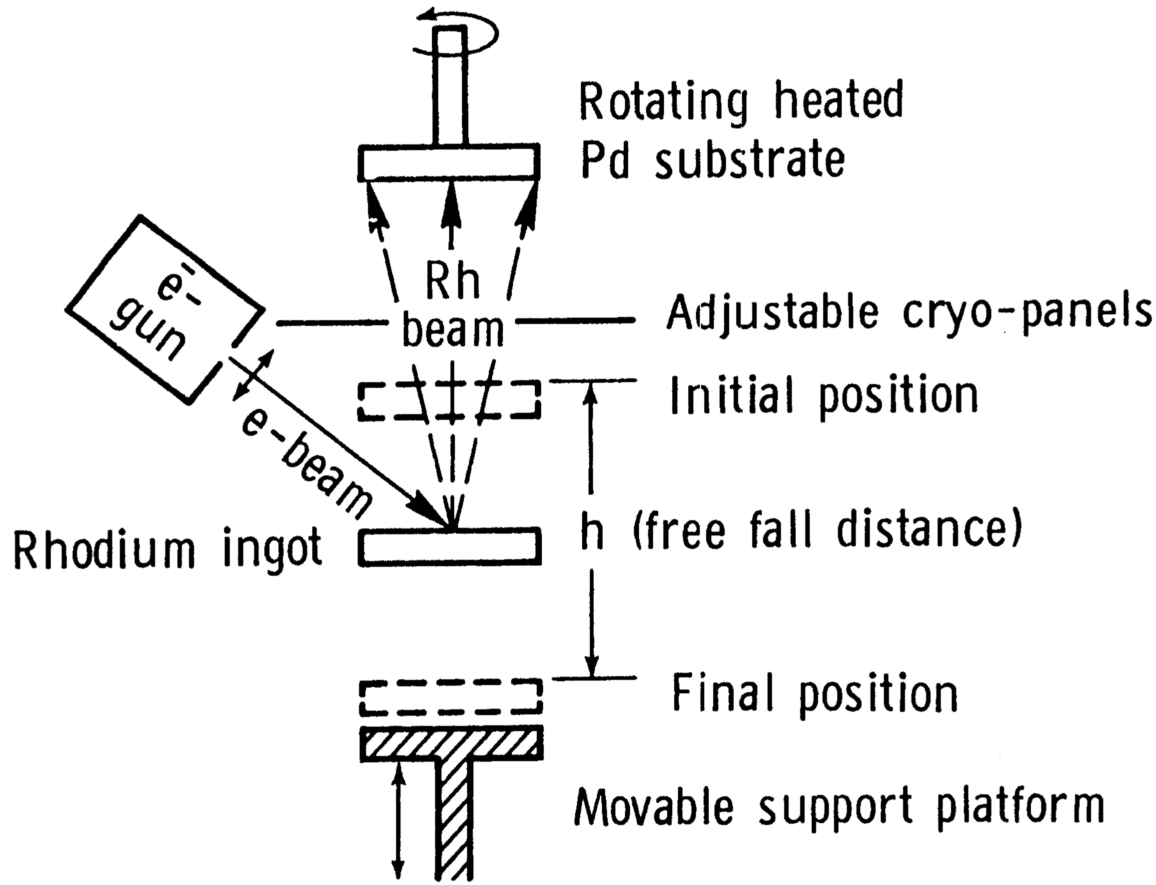
- Develop Pd^{103}-Rh^{103} Mossbauer gravitometer for use in aerial and/or bore-hole surveys on earth

EXPERIMENTAL PROCEDURE

Adapt an MBE crystal growth system for making an effectively wall-less Rhodium effusion cell

- Arrange electron beam heating of Rhodium charge falling freely through a preselected distance
- Repeat this "free fall evaporation" process until a Rhodium film of 500Å-1000Å thickness is produced
- Periodically monitor the crystalline quality of the Rhodium films by low energy and high energy electron diffractometry
- If necessary, adjust the palladium substrate temperature and energy/intensity of the heating electron beam for appropriate Rhodium film production

SCHEMATIC DIAGRAM OF THE FREELY FALLING ELECTRON BEAM RHODIUM DEPOSITION SOURCE



EXPERIMENT TITLE: Growth of Thin Single Crystal Films of Rhodium

PROPOSED FLIGHT DATE - 1990-1992 YEAR (first year of operation)

OPERATIONAL DAYS REQUIRED - 10

MASS - 1.0 KG

VOLUME: *

STORED: W 0.15 x L 0.15 x H 0.15 = 0.0034 M^3

DEPLOYED: W 0.15 x L 0.15 x H 0.15 = 0.0034 M^3

INTERNALLY ATTACHED √ (YES/~~NO~~)
EXTERNALLY ATTACHED ____ (~~YES~~/NO)
FORMATION FLYING ____ (~~YES~~/NO)

ORIENTATION (inertial, solar, earth, other) Inertial or earth

EXTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: ____ Hrs/Day ____ No. of days

OPERATIONS: ____ Hrs/Day ____ No. of days ____ Interval

SERVICING: ____ Hrs/Day ____ No. of days ____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: ____ Hrs/Day ____ No. of days

OPERATIONS: ____ Hrs/Day ____ No. of days ____ Interval

SERVICING: ____ Hrs/Day ____ No. of days ____ Interval

POWER REQUIRED:

10 KW AC or DC (circle one)

4 Hrs/Day 10 No. of days

DATA RATE: N/A Megabits/second

DATA STORAGE: N/A Gigabits

*It is assumed that the materials processing facility onboard the space station will have an MBE crystal growth system.

Singh and Spijkerman

GROWTH OF COMPOUND SEMICONDUCTOR CRYSTALS

A. L. FRIPP, I. O. CLARK, W. J. DEBNAM
NASA LANGLEY RESEARCH CENTER, HAMPTON, VA 23665-5225

AND

R. K. CROUCH
NASA HEADQUARTERS, WASHINGTON, DC 20546

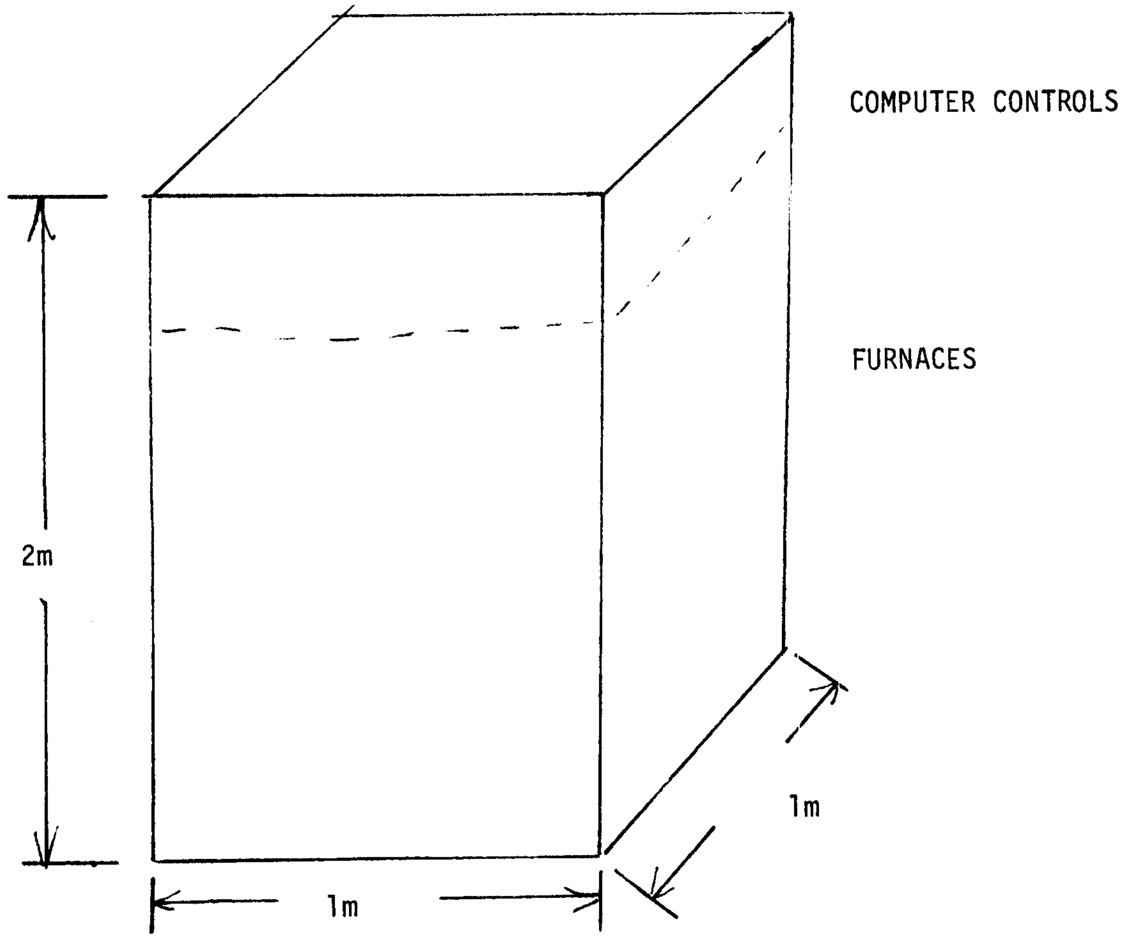
OBJECTIVE: THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP THE CAPABILITY OF PERFORMING MATERIALS GROWTH RESEARCH IN THE SPACE STATION FOR BOTH THE ATTAINMENT OF BASIC KNOWLEDGE AND THE PRE-PILOT LINE PRODUCTION OF COMMERCIALLY FEASIBLE MATERIALS.

GROWTH OF COMPOUND SEMICONDUCTOR CRYSTALS

EXPERIMENT DESCRIPTION:

THE EXPERIMENTS CONSIST OF DEVELOPING HIGH QUALITY FURNACES TO CONTINUE AND EXTEND THE MICROGRAVITY SCIENCE EFFORT THAT IS CURRENTLY UNDERWAY USING THE SPACE SHUTTLE. THE SPACE STATION WILL PROVIDE A LARGER, LOWER GRAVITY ENVIRONMENT THAT IS CONDUCIVE TO "HANDS-ON" EXPERIMENTS. THE LARGER NUMBER OF EXPERIMENTS THAT CAN BE PERFORMED PER YEAR OVER THAT OBTAINABLE WITH THE SPACE SHUTTLE WILL PROVIDE A STRONGER SCIENCE BASE THAT WILL LEAD TO THE SELECTION OF MATERIAL SYSTEMS THAT ARE FEASIBLE FOR COMMERCIAL PRODUCTION IN SPACE.

THE POTENTIAL ECONOMIC BENEFITS ARE THE COMMERCIAL PRODUCTION OF UNIQUE COMPOUND SEMICONDUCTOR CRYSTALS WHICH CANNOT BE GROWN IN EARTH GRAVITY. THE AVAILABILITY OF THE FACILITIES DEVELOPED ON THIS PROJECT WILL MAKE SPACE PROCESSING MORE ATTRACTIVE TO INDUSTRY THAN IF THE APPARATUS HAD TO BE DEVELOPED BY THE PARTICIPATING INDUSTRY.



CRYSTAL GROWTH FURNACE AND CONTROLS

EXPERIMENT TITLE: TDM-2022, Growth of Compound Semiconductor Crystals

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - 365

MASS - 200 KG

VOLUME:

STORED: W 1 x L 1 x H 2 = 2 M^3

DEPLOYED: W 1 x L 1 x H 2 = 2 M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED no (YES/NO)
FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) any

EXTRA-VEHICULAR ACTIVITY REQUIRED: none

SET-UP: ____ Hrs/Day ____ No. of days

OPERATIONS: ____ Hrs/Day ____ No. of days ____ Interval

SERVICING: ____ Hrs/Day ____ No. of days ____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 8 Hrs/Day 1 No. of days

OPERATIONS: 2 Hrs/Day 365 No. of days 1 Interval

SERVICING: 8 Hrs/Day 4 No. of days 90 Interval

POWER REQUIRED:

2.5 KW AC or DC (circle one) either

24 Hrs/Day 365 No. of days

DATA RATE: 0.2 Megabits/second

DATA STORAGE: 0.2 Gigabits

HIGH VOLTAGE IN SPACE PLASMA

JAMES McCOY, RICHARD WILLIAMS

NASA-JSC

OBJECTIVE:

TO PROVIDE A TECHNOLOGY BASE FOR UNDERSTANDING THE GENERATION, DISTRIBUTION AND USE OF HIGH VOLTAGES IN THE LEO PLASMA. INCLUDED ARE INTERACTIONS OF HIGH VOLTAGE SOLAR ARRAYS, HIGH POWER DISTRIBUTION SYSTEMS, ELECTRODYNAMIC TETHERS, ELECTRIC PROPULSION SYSTEMS, AND HIGH VOLTAGE PAYLOADS SUCH AS PARTICLE ACCELERATORS AND ELECTRON PUMPED LASERS.

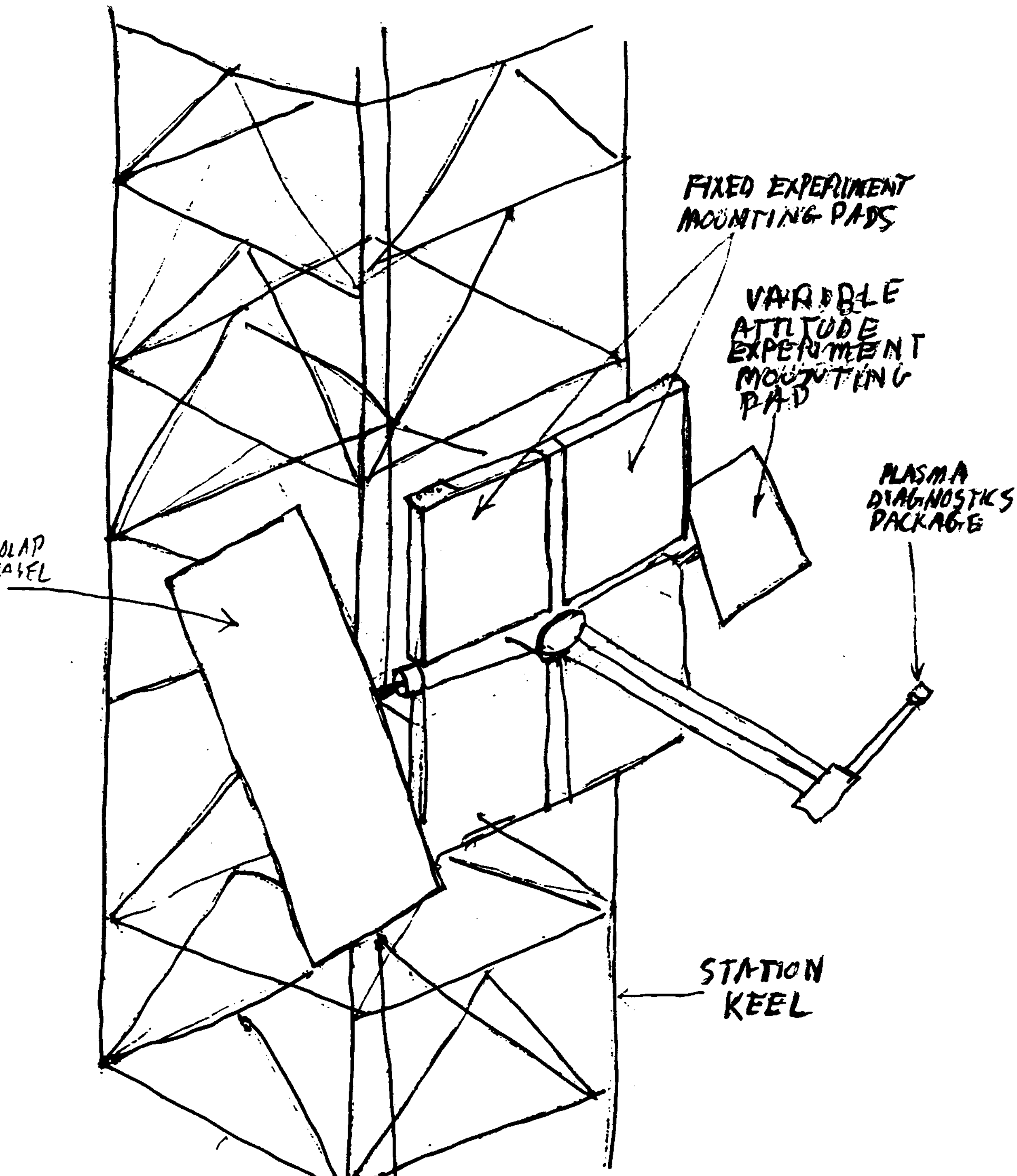
DESCRIPTION:

THE MISSION PROPOSED WILL PROVIDE A PERMANENT FACILITY TO EXPERIMENTALLY TEST THE PERFORMANCE OF SYSTEM COMPONENTS IN THE LEO ENVIRONMENT WITH SUFFICIENT INSTRUMENTATION AND CONTROL TO INSURE SPACE QUALIFICATION OF NEW CONCEPTS. HIGH VOLTAGE SYSTEMS INTERACT WITH THE LEO PLASMA THROUGH THE FOLLOWING MECHANISMS: PLASMA INDUCED ARCING, PARASITIC LEAKAGE CURRENTS, MATERIAL DEGRADATION THROUGH ION SPUTTERING, UV AND PHOTOELECTRON CONDUCTION, VxB INDUCED POTENTIALS, AND TRANSPORT OF CHARGE AND MATERIAL BY SPACECRAFT GENERATED PLASMAS. SINCE HIGH ELECTRICAL POWER REQUIRES HIGH VOLTAGE SYSTEMS, SUCH A TEST FACILITY IS NECESSARY FOR NEXT GENERATION SPACE STATION DEVELOPMENT.

THE APPROACH IS TO USE CORE EQUIPMENT AND EXPERIMENT TEST BED WITH STANDARDIZED, PLUG IN INTEGRATION OF TEST ITEMS.

CORE EQUIPMENT INCLUDES SOLAR ARRAY, HIGH VOLTAGE POWER SOURCE, DATA COMPUTER, DIAGNOSTICS, AND PLASMA GROUND.

EXPERIMENT ATTACHMENTS FOR HIGH VOLTAGE (1 KW AT UP TO 10 KV AND 1 KHZ), DATA CHANNELS (UP TO 10 Kb); AND 2 AXIS POINTING.



Preliminary sketch of test bed and core assembly

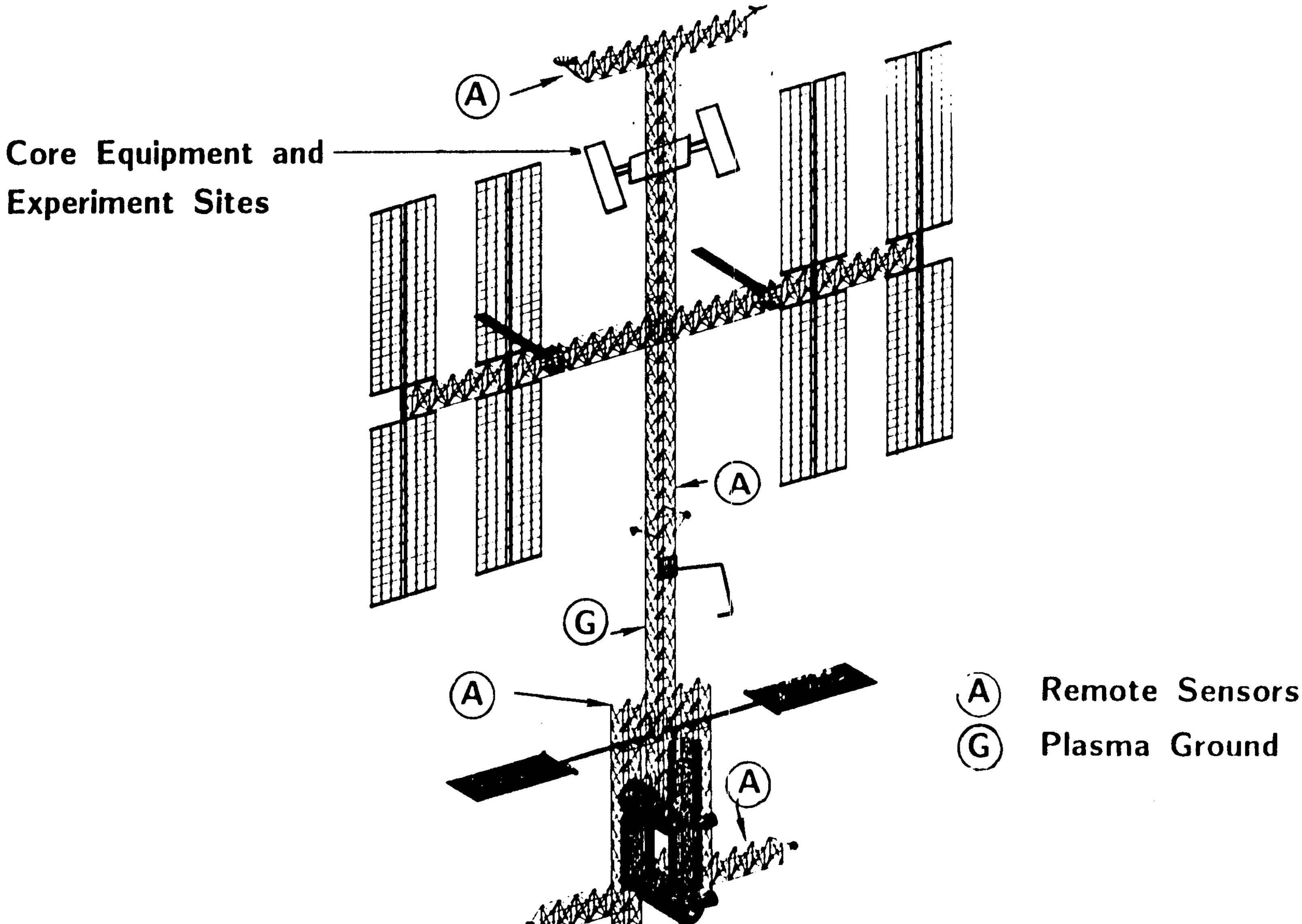


Figure 4.3.7.4-1 IOC reference configuration space station.

Locations should be compatible with tether attachment

EXPERIMENT TITLE: High Voltage in Space Plasma

PROPOSED FLIGHT DATE - 1994/5 YEAR

OPERATIONAL DAYS REQUIRED - Continuous

MASS - 30 KG (6 systems at various sites)

VOLUME: (Per system)

STORED: W 4 x L 10 x H 0.1 = 40 M^3

DEPLOYED: W 4 x L 10 x H 4 = 400 M^3

INTERNALLY ATTACHED No (YES/NO)
EXTERNALLY ATTACHED Yes (YES/NO)
FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) Unobstructed hemisphere (Approx. 10 m rad.) in ram direction

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: TBD Hrs/Day ______ No. of days

OPERATIONS: TBD Hrs/Day ______ No. of days ______ Interval

SERVICING: TBD Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: TBD Hrs/Day ______ No. of days

OPERATIONS: TBD Hrs/Day ______ No. of days ______ Interval

SERVICING: TBD Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED: (Experiment provided)

______ KW AC or DC (circle one)

______ Hrs/Day ______ No. of days

DATA RATE: ______ Megabits/second

10 Kb

DATA STORAGE: ______ Gigabits

Note: This is best viewed as a "facility" on which plasma experiments can be mounted.

National Aeronautics and Space Administration

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VOLTAGE OPERATING LIMIT TESTS (VOLT-A) SHUTTLE EXPERIMENT

EXPERIMENT OBJECTIVE: ACQUIRE AND ANALYZE DATA ON THE INTERACTIONS BETWEEN HIGH VOLTAGE SOLAR CELL PANELS AND THE SPACE PLASMA ENVIRONMENT TO ENABLE DEVELOPMENT OF DESIGN CRITERIA FOR FUTURE HIGH POWER SOLAR CELL ARRAYS.

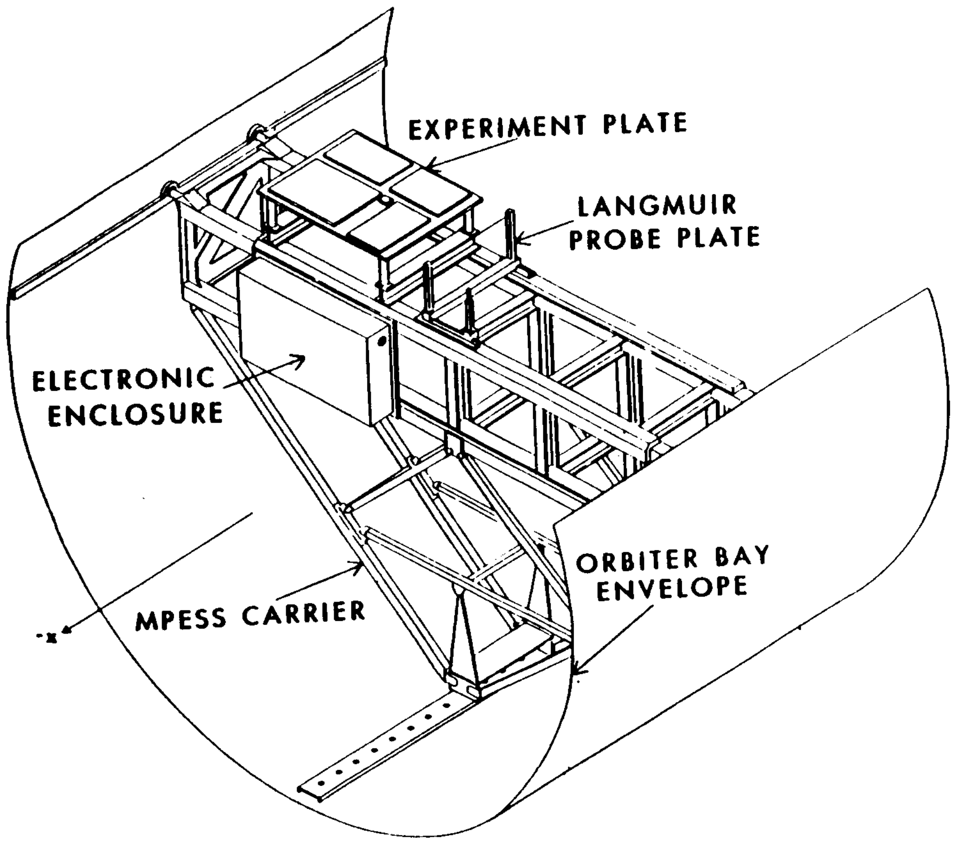
EXPERIMENT DESCRIPTION: VOLT-A CONSISTS OF AN EXPERIMENT PLATE WHICH CONTAINS FOUR SMALL SOLAR CELL PANELS, AN ELECTRONICS SUBASSEMBLY AND A LANGMUIR PROBE SUBASSEMBLY MOUNTED ON AN MPESS CARRIER. DURING A GIVEN 8.25 HOUR DATA TAKING PERIOD (5-1/2 CONTINUOUS ORBITS), THE SOLAR CELL PANELS, WHICH REPRESENT A RANGE OF TECHNOLOGIES, WILL BE SEQUENTIALLY SUBJECTED TO BIAS VOLTAGES IN STEPS RANGING FROM MINUS 626 V TO PLUS 313 V. APPROPRIATE MEASUREMENTS WILL BE MADE AT EACH VOLTAGE TO CHARACTERIZE ARCING AND PARASITIC LOSSES. CORRESPONDING MEASUREMENTS OF THE PLASMA ENVIRONMENT (PLASMA DENSITY, ELECTRON TEMPERATURE AND NEUTRAL DENSITY) WILL ALSO BE MADE. DATA WILL BE RECORDED ON AN ON-BOARD TAPE RECORDER FOR SUBSEQUENT DATA REDUCTION AND ANALYSIS.

WILLIAM J. BIFANO

National Aeronautics and Space Administration
Lewis Research Center

SPACE EXPERIMENTS OFFICE

VOLT-A ON MPESS

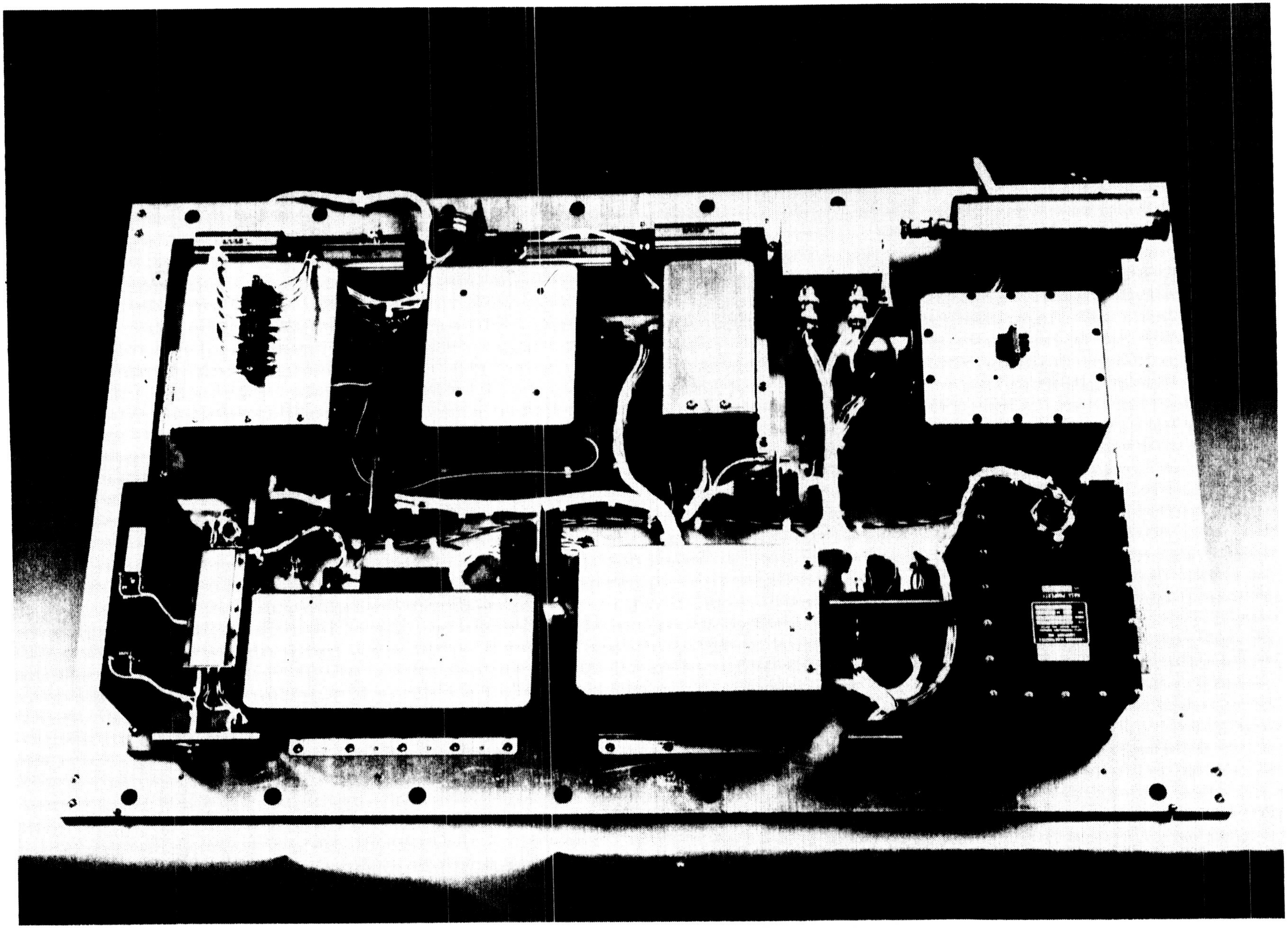


EXPERIMENT PLATE (125 LBS)
- 4 MODULE PLATES (SI CELLS)
  5.9 X 5.9-CM (3)
  PIX II 2 x 2-CM
- SUN SENSOR

LANGMUIR PROBE PLATE (25 LBS)
- LANGMUIR PROBES
  CYLINDRICAL
  SPHERICAL

ELECTRONIC ENCLOSURE (150 LBS)
- POWER SUPPLY/CONDITIONING
- SEQUENCER
- VACUUM GAUGE
- HEATERS

WILLIAM J. BIFANO



VOLT-A FLIGHT ELECTRONICS SUBASSEMBLY

EXPERIMENT TITLE: Voltage Operating Limit Test

PROPOSED FLIGHT DATE - 1987 - 88 YEAR

OPERATIONAL DAYS REQUIRED - 1 [8.25 hrs per data take period (5-1/2 orbits) 3 periods requested.]

MASS - 135 KG

VOLUME: (Overall envelope)

STORED: W 1.07 x L 1.9 x H 1.12 = 2.28 M^3

DEPLOYED: W 1.07 x L 1.9 x H 1.12 = 2.28 M^3

INTERNALLY ATTACHED Yes (YES/NO)
EXTERNALLY ATTACHED No (YES/NO)
FORMATION FLYING Yes (YES/NO)

ORIENTATION (inertial, solar, earth, other) Variable (ram, wake, sun, anti-sun)

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0 Hrs/Day ______ No. of days

OPERATIONS: 0 Hrs/Day ______ No. of days ______ Interval

SERVICING: 0 Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0.2 Hrs/Day 1 No. of days

OPERATIONS: 0 Hrs/Day ______ No. of days ______ Interval

SERVICING: 0 Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED:

0.11 (Avg) KW AC or DC (circle one)

24 Hrs/Day 7 No. of days

DATA RATE: N/A Megabits/second
DATA STORAGE: N/A Gigabits

Self contained multiplexer, memory and tape recorder

STATUS - Flight electronics in electrical test.

- Funding required to procure experiment plate and for qualification and flight of system.

PLUME PROPERTIES MEASUREMENTS EXPERIMENT

Leonard T. Melfi, Jr.
Space Systems Division
NASA Langley Research Center

In-Space Research, Technology, and
Engineering Workshop

Williamsburg, Virginia
October 8–10, 1985

EXPERIMENT OBJECTIVES

To measure the flow—field properties of the exhaust plume of a VRCS rocket engine.

- Species Density
- Flow Velocity
- Flow Angle
- Temperature

Analyze the experimentally determined flow properties and correlate with properties derived from a flow—field solution generated by the Direct Simulation Monte Carlo method.

Determine the level of correlation.

Determine model parameters which yield best agreement.

R,T&E WORKSHOP
L. T. MELFI
SLIDE 2

EXPERIMENT DESCRIPTION

Experiment erection (EVA) (Shuttle VRCS L5L)

Experiment execution (mission specialist)

Prescribed measurement point grid (M x N)

- Distributed over rarefied flow region of plane
- In axisymmetric flow plane

Instrument orientation scan (in plane)

- Measure and record total ion current
- Determine local flow direction (real time)

Mass spectrometric analysis of plume gas

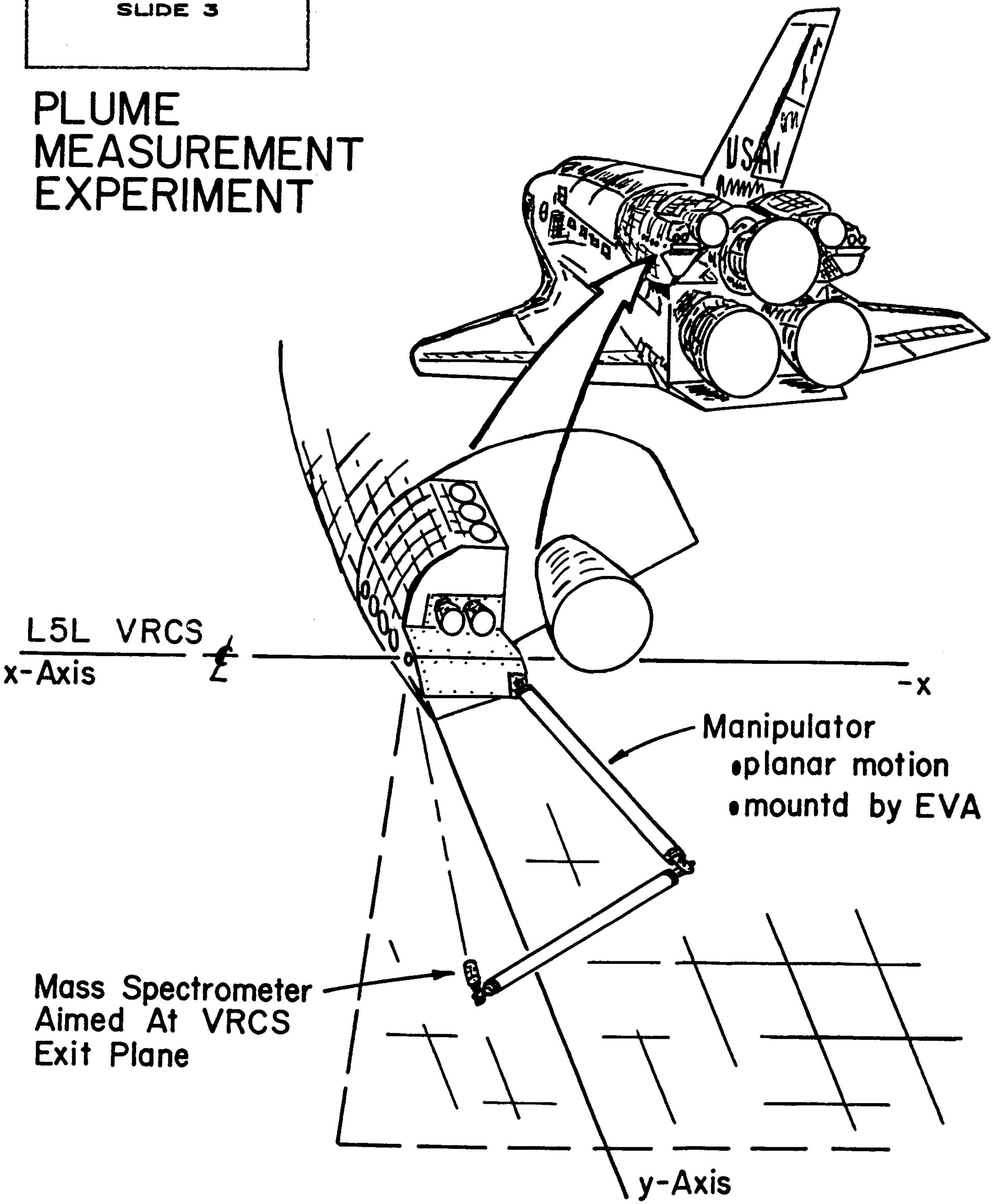
- Measure and record ion current for each species at each grid point
- Determine local species number density

Energy analysis of ion current

- Measure and record energy distribution of total ion current at each grid point
- Determine local flow velocity
- Determine local temperature

R.T&E WORKSHOP
L. T. MELFI
SLIDE 3

PLUME MEASUREMENT EXPERIMENT



R.T&E WORKSHOP
L. T. MELFI
SLIDE 4

Experiment Title: Plume Properties Measurements

Proposed Flight Date: Cy 1990 Year

Mass: < 100 KG

Volume:

Stored	W < 1	x L < 2	x H < 3	= < 6	M(3)
Deployed	W < 1	x L < 5	x H < 15	= < 75	M(3)

Internally Attached Yes (Yes/No)
Externally Attached Yes (Yes/No)
Formation Flying No (Yes/No)

Orientation: Measurement plane shielded from freestream gas

Extra-Vehicular Activity Required:

Set-Up:	4	Hrs/Day	1	No. of Days		
Operations:	-	Hrs/Day	-	No. of Days	-	Interval
Servicing:	-	Hrs/Day	-	No. of Days	-	Interval

Intra-Vehicular Activity Required:

Set-Up:	6	Hrs/Day	1	No. of Days		
Operations:	15	Hrs/Day	1	No. of Days	-	Interval
Servicing:	-	Hrs/Day	-	No. of Days	-	Interval

Power Required: 0.2 KW AC or DC (Circle one)
15 Hrs/Day 1 No. of Days

Data Rate: 0.02 Megabits/second

Data Storage: 0.1 Gigabits

National Aeronautics and
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POWER TECHNOLOGY DIVISION

NASA

LONG TERM EFFECTS OF SPACE EXPOSURE ON MATERIALS

M. J. MIRTICH

B. A. BANKS

NASA LEWIS RESEARCH CENTER

National Aeronautics and
Space Administration
Lewis Research Center

POWER TECHNOLOGY DIVISION

OBJECTIVES:

- TO EVALUATE ON A REAL TIME BASIS, OPTICAL CONSEQUENCES OF THE LONG-TERM EXPOSURE OF PROTECTIVE COATINGS AND OTHER POTENTIAL DURABLE MATERIALS SUBJECTED TO THE COMBINED EFFECTS OF RAM ATOMIC OXYGEN, ULTRAVIOLET RADIATION, AND LAUNCH VEHICLE/SPACE STATION INDUCED CONTAMINANTS.

- TO EVALUATE THE REACTION RATES OF VARIOUS MATERIALS EXPOSED TO ATOMIC OXYGEN REFLECTED FROM SEVERAL TYPES OF TYPICAL SPACECRAFT SURFACES.

EXPERIMENT

- OPTICAL CHARACTERIZATION CAROUSEL
  - PROTECTIVE COATINGS (SOME PRE-EXPOSED TO SIMULATED MICROMETEROIDS) AND POTENTIAL DURABLE MATERIALS.
  - EXPOSE SAMPLES TO RAM ATOMIC OXYGEN (A/O) PLUS THE TOTALITY OF THE SPACE STATION ENVIRONMENT.
  - REAL-TIME, LONG-DURATION SPECTRAL REFLECTANCE MEASUREMENTS (.3 TO15 UM).
  - LONG-TERM SPECTRAL SIGNATURE AND COLOR CENTERS, INFO.
  - SOLAR ABSORPTANCE.
  - THERMAL EMITTANCE.

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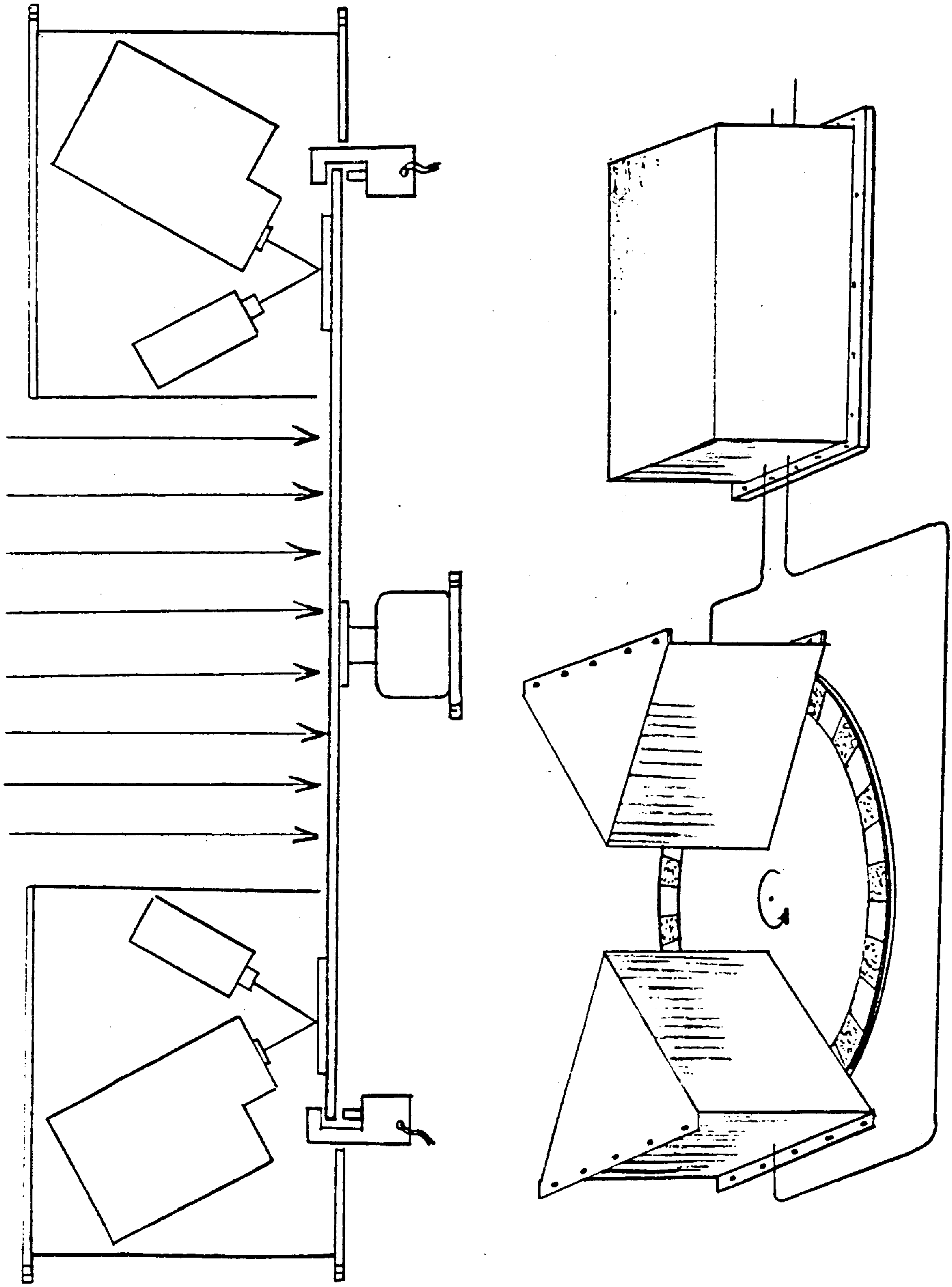
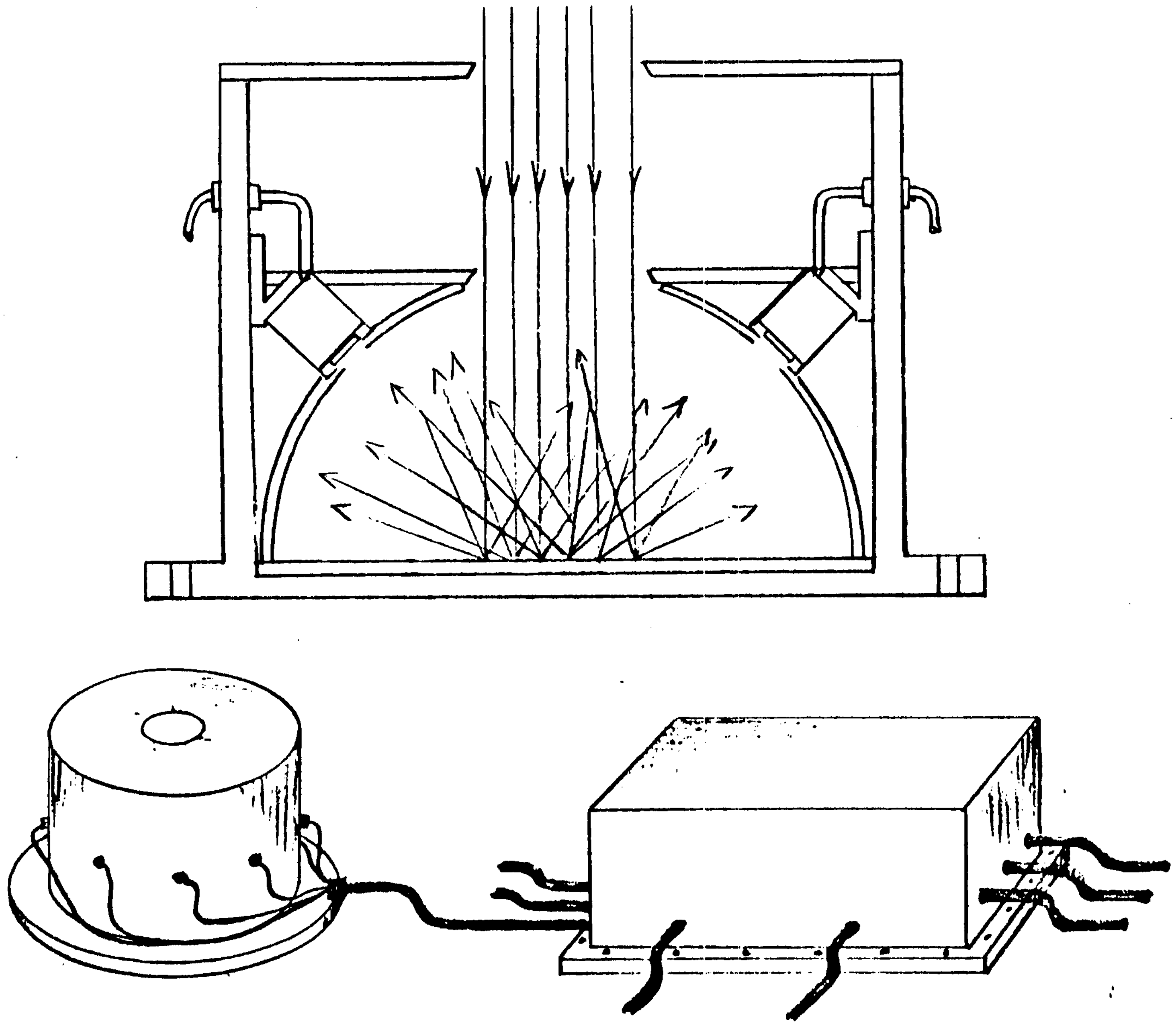
- o REFLECTED ATOMIC OXYGEN REACTION RATE APPARATUS
  - REACTIVE SURFACES (AG, PTFE, FEP, GRAPHITE/EPOXY, POLYETHYLENE, CARBON, KAPTON, MYLAR).
  - A/O REFLECTION SURFACES (AL, TI, STAINLESS STEEL, MG, FEP, KAPTON).
  - REACTIVE SURFACES BONDED TO QCM's.
  - REAL-TIME LONG-TERM WEIGHT LOSS MEASUREMENTS.

OPTICAL CHARACTERIZATION CARROUSEL



REFLECTED ATOMIC OXYGEN REACTION RATE APPARATUS



EXPERIMENT TITLE: LONG TERM EFFECTS OF SPACE EXPOSURE ON MATERIALS

PROPOSED FLIGHT DATE - 1993 YEAR

OPERATIONAL DAYS REQUIRED - 365

MASS - 205 KG

VOLUME:

STORED: W 712 cm x L 534 cm x H 261 cm = 99.2 M^3

DEPLOYED: W 712 cm x L 534 cm x H 261 cm = 99.2 M^3

INTERNALLY ATTACHED YES (YES/NO)
EXTERNALLY ATTACHED YES (YES/NO)
FORMATION FLYING ______ (YES/NO)

ORIENTATION (inertial, solar, earth, other) RAM

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	2	Hrs/Day	1	No. of days		
OPERATIONS:	N/A	Hrs/Day		No. of days		Interval
SERVICING:	2	Hrs/Day	6	No. of days	1/2 MONTHS	Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP:	8	Hrs/Day	1	No. of days		
OPERATIONS:	2	Hrs/Day	52	No. of days	1/WEEK	Interval
SERVICING:	1	Hrs/Day	6	No. of days	1/2 MONTHS	Interval

POWER REQUIRED:

1 KW AC or DC (circle one)

2 Hrs/Day 52 No. of days

DATA RATE: N/A Megabits/second - 3000/2 hrs = 1500 bits/hr

DATA STORAGE: N/A Gigabits - TRANSMIT TO EARTH

EXPERIMENT OBJECTIVE

The objective of this experiment is to bring the unique capabilities of reactive scanning electron microscopy to the service of the study of materials, chemically reacting systems, and biological systems under microgravity conditions. It will provide SEM reactors in which materials can be studied at extreme temperatures while undergoing solid/gas reactions in a microgravity environment. It will also provide biological reactors in which living cells can be studied in the SEM under microgravity conditions.

In the case of materials studies, this will permit the microscopic study of materials and reacting solid/gas systems under conditions that they may realistically be expected to encounter in space applications. In the case of biological systems, this will provide for the microscopic study of biological cells as they develop and reproduce in an environment devoid of the orienting gravity vector. The results of these latter experiments are likely to have important implications regarding future biological processing in space.

EXPERIMENT DESCRIPTION

In this experiment scanning electron microscopy (SEM) is extended to the study of systems reacting under stringently specified conditions.

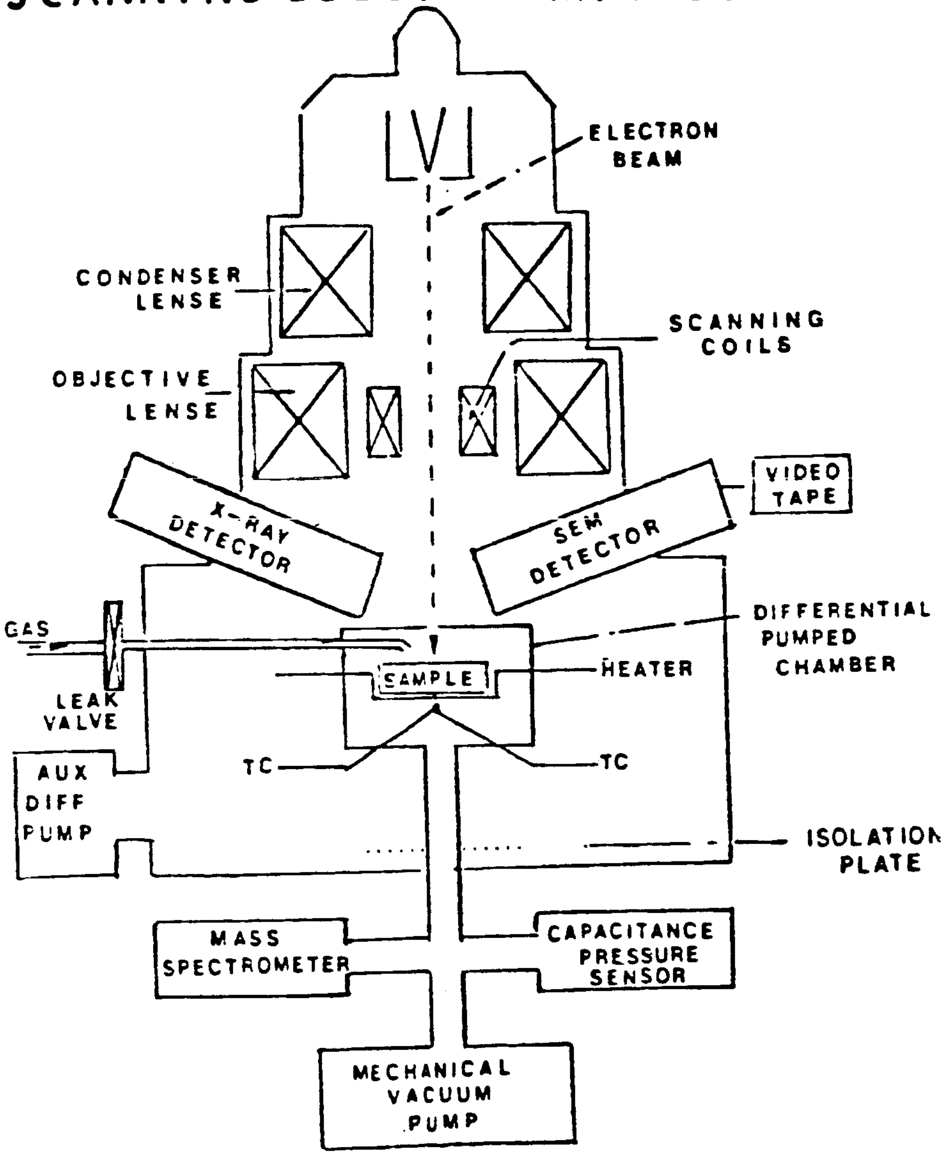
Reactors are provided to study two different types of systems: high temperature solid/gas reactions and biological reactions.

The high temperature reactions are studied in a specially designed SEM reactor that operates up to 1600 C and 5 torr (presently being extended to 2000 C). Resolution is 300 A. X-ray elemental analyses are included up to 1000 C. It is proposed to extend the limits of operation to above 3000 C and one atmosphere by laser heating and differential pumping. The existing system can be coupled with a mass spectrometer to provide continuous gas analysis during reaction. It has been used to study soot deposition, catalytic cracking of acetylene over iron, oxidation of refractory metals, and oxidation, reduction and pyrolysis of coke. These accomplishments may readily be extended to similar studies under microgravity spacelab conditions.

The biological stage is under development (NSF SBIR Grant 1R43GM33627-01A1). It will provide an atmosphere in which biological cells remain viable while under observation in a SEM. With this system cells will be observed with a resolution of approximately 300 A as they pass through their life cycles. All known biological systems have developed in an environment of approximately one g. This experiment will permit microscopic study of simple biological systems under the extraordinary environment of microgravity. Multiple generations of microorganisms may be studied under this unusual and important condition.

D.W. Blair, High Temperature Controlled Atmosphere Reactions in the Scanning Electron Microscope

CONTROLLED ATMOSPHERE SCANNING ELECTRON MICROSCOPY



D.W. Blair, High Temperature Controlled Atmosphere Reactions in the Scanning Electron Microscope

EXPERIMENT TITLE: High Temperature Controlled Atmosphere Reactions in the Scanning Electron Microscope

PROPOSED FLIGHT DATE - TBD YEAR

OPERATIONAL DAYS REQUIRED - TBD

MASS - 200 KG

VOLUME:

STORED: W 0.6 x L 2 x H 1.5 = 1.8 M^3

DEPLOYED: W 0.6 x L 2 x H 1.5 = 1.8 M^3

INTERNALLY ATTACHED Yes (YES/NO)
EXTERNALLY ATTACHED No (YES/NO)
FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) TBD

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0 Hrs/Day 0 No. of days

OPERATIONS: 0 Hrs/Day 0 No. of days 0 Interval

SERVICING: 0 Hrs/Day 0 No. of days 0 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: TBD Hrs/Day TBD No. of days

OPERATIONS: TBD Hrs/Day TBD No. of days TBD Interval

SERVICING: TBD Hrs/Day TBD No. of days TBD Interval

POWER REQUIRED:

2 KW AC or DC (circle one)

TBD Hrs/Day TBD No. of days

DATA RATE: TBD Megabits/second

DATA STORAGE: TBD Gigabits

ON-ORBIT CONTAMINATION CONTROL

W. SAYLOR, G.E. SPACE DIVISION
VALLEY FORGE, PA.

OBJECTIVE: ON ORBIT SERVICING OF OPTICAL/THERMAL CONTROL SURFACES.

GROUND OPERATION CONTAMINATION CONTROL AND PRE LAUNCH CLEANING NOT ENOUGH FOR LONG TERM MANNED MISSIONS.

ON-ORBIT SERVICING OF CRITICAL SURFACES WILL BE REQUIRED.

SURFACE REFURBISHMENT METHODS *

TWO CATEGORIES

1. SURFACE RESTORATION
(CONTAMINANT REMOVAL TO RESTORE INITIAL PROPERTIES)

- REACTIVE GAS PLASMA (ATOMIC OXYGEN)
- SPUTTER ETCHING
- MECHANICAL ABRASION
- SOLVENT CLEANING
- PULSED ENERGY (ELECTRICAL/LASER)

2. SURFACE REPLACEMENT
(REMOVAL AND REPLACING SURFACE OR COVERING OVER AN OLD SURFACE WITH NEW)

- STRIPPABLE/REPLACEABLE FILMS
- DIRECT PANEL REPLACEMENT
- RECOATING (PAINT SPRAYING)

* WORK SUPPORTED BY MSFC (NAS8-35342)

ON-ORBIT CONTAMINATION CONTROL

W. SAYLOR, G.E. SPACE DIVISION
VALLEY FORGE, PA.

ON-ORBIT SERVICING EVALUATION RESULTS

THREE METHODS JUDGED POTENTIALLY USEFUL:

- REACTIVE GAS PLASMA (ATOMIC OXYGEN CLEANING)

  EFFECTIVE FOR MOST ALL SURFACE RESTORATION

  LABORATORY DEMONSTRATED EFFECTIVE
  (A 10 μGM/CM^2 CONTAMINATION DEPOSIT CAN BE CLEANED FROM A 20 FT^2 PANEL IN ONE HOUR USING A 12" DIAMETER SOURCE AT 5 WATTS.)

  EASE OF APPLICATION/SAFE FOR MOST SUBSTRATES

  COST EFFECTIVE/ADAPTABLE FOR ROUTINE, RAPID EMPLOYMENT

- STRIPPABLE/RENEWABLE SURFACE REPLACEMENT

  EFFECTIVE FOR SURFACE FILM REPLACEMENT

  NOT DEMONSTRATED BUT APPEARS DEVELOPABLE

- RECOATING BY PAINT SPRAYING

  EFFECTIVE FOR RECOATING DEGRADED PAINT SURFACES IN SPACE

  DEMONSTRATED EFFECTIVE BY JSC

ON-ORBIT CONTAMINATION CONTROL

W. SAYLOR, G.E. SPACE DIVISION
VALLEY FORGE, PA.

PROPOSED EXPERIMENT:

- PERFORM A SYSTEM ANALYSIS OF THE FEASIBILITY OF EACH OF THE REFURBISHMENT METHODS FOR SPECIFIC MISSIONS

- ATOMIC OXYGEN CLEANING

  OPTIMIZE THE ATOMIC OXYGEN CLEANING DEVICE FOR USE AS AN ON-ORBIT EXPERIMENTAL SYSTEM (DESIGN OF AN EFFICIENT LOW VOLTAGE POWER SUPPLY, PROPER PACKAGING, ETC.)

  PERFORM CLEANING TRIALS ON SHUTTLE FLIGHTS/FINALIZE SYSTEM.

- PAINT SPRAYING

  RE-EXAMINE WITH THE GOAL OF DESIGN IMPROVEMENTS LEADING TO AN ACTUAL ON-ORBIT DEMONSTRATION, AGAIN VIA A SHUTTLE FLIGHT.

- STRIPPABLE/REPLACEABLE FILMS

  A CONCEPT DESIGN PROGRAM SHOULD BE INITIATED LEADING TO, FIRST, A GROUND TEST OF A FILM APPLICATOR AND THEN TO AN ORBITAL TEST.

NOTE:

GE PRESENTLY ADAPTING "UV-OZONE CLEANING" TO A PORTABLE DEVICE FOR PRE-LAUNCH SERVICING OF CRITICAL SURFACES. THE METHOD HAS PROVED EFFECTIVE, SIMPLE AND SAFE TO OPERATE REQUIRING NO PHYSICAL CONTACT TO SUBSTRATE. ALL ORGANIC RESIDUE IS REMOVED WITH NO DEGRADATION TO CRITICAL SUBSTRATE.

EXPERIMENT TITLE: ON-ORBIT CONTAMINATION CONTROL

W. SAYLOR G.E. SPACE DIVISION
VALLEY FORGE, PA.

PROPOSED FLIGHT DATE - 1988-1990 YEAR

OPERATIONAL DAYS REQUIRED - 1-2

MASS - not designed KG

VOLUME: not designed

STORED: W ______ x L ______ x H ______ = ______ M^3

DEPLOYED: W ______ x L ______ x H ______ = ______ M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED ______ (YES/NO)
FORMATION FLYING ______ (YES/NO)

ORIENTATION (inertial, solar, earth, other) any

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: 4 Hrs/Day 1-2 No. of days ______ Interval

SERVICING: -- Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: -- Hrs/Day ______ No. of days ______ Interval

SERVICING: -- Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED:

0.005 KW AC or DC (circle one)

4 Hrs/Day 1-2 No. of days

DATA RATE: -- Megabits/second

DATA STORAGE: -- Gigabits

SPACE ULTRA-VACUUM FACILITY

OBJECTIVE:

PROVIDE CAPABILITY TO ACCOMMODATE ULTRA-VACUUM EXPERIMENT

DESCRIPTION:

SELF-CONTAINED WAKE SHIELD AND SUPPORTING EQUIPMENT CAN BE ATTACHED TO THE SPACE STATION (GRAPPLER AND/OR TETHER) OR USE FREE FLYER MODE. SCIENTIFIC AND COMMERCIAL APPLICATIONS WILL BE ACCOMMODATED.

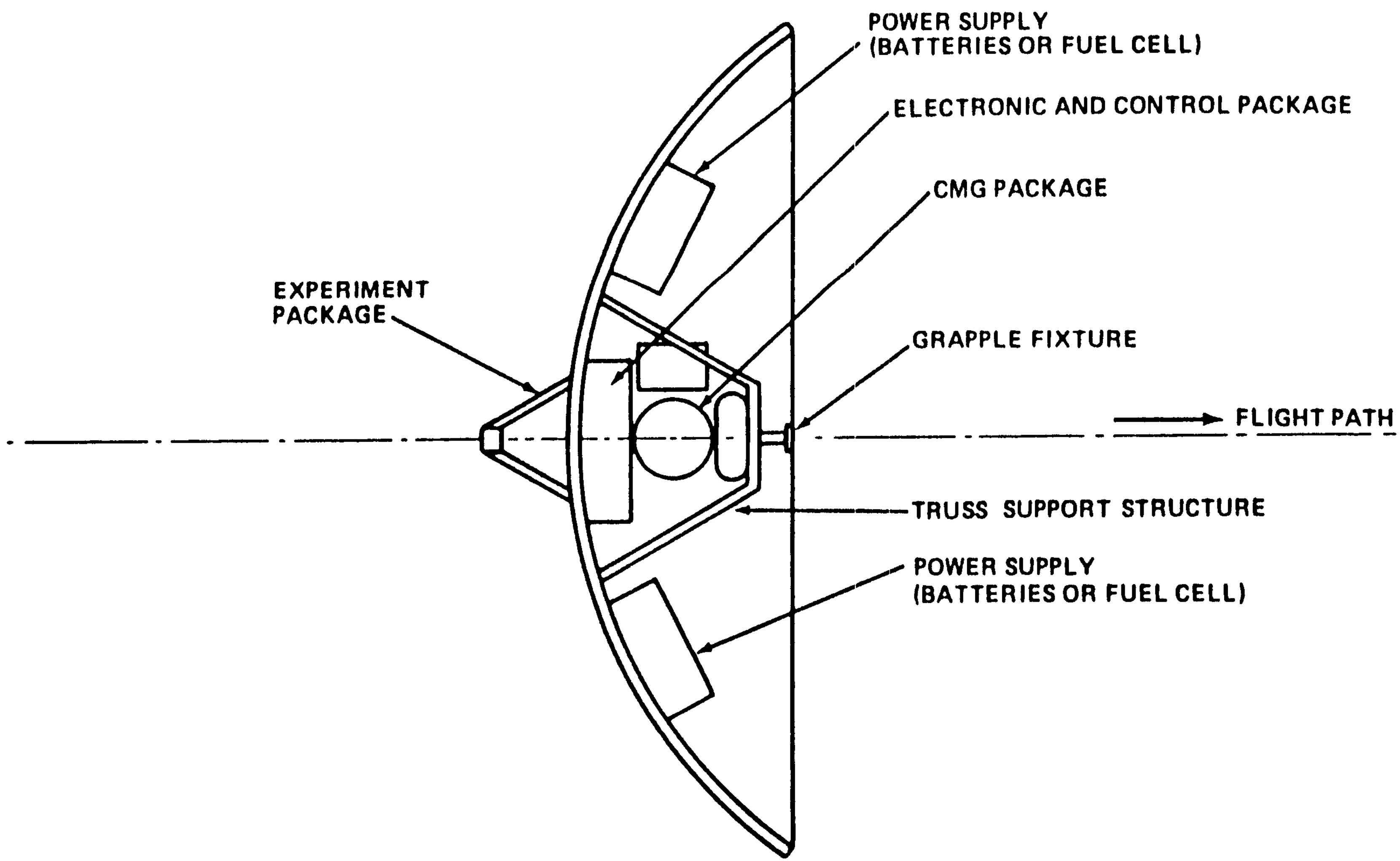
FEATURES:

- ELIMINATION OF CONTAMINATION
- ULTRAHIGH VACUUM CAPABILITY (10^{-14} TORR)
- VIRTUAL INFINITE PUMPING SPEED
- DISSIPATE LARGE HEAT LOADS WITH NO EFFECT ON VACUUM LEVELS
- MAXIMUM PROCESSING FLEXIBILITY

POSSIBLE USES:

- THIN FILM GROWTH (MBE/PVD/CVD/MOCUD)
- COATING LARGE SURFACE (I.E., SPACE MIRRORS)
- ULTRA-PURIFICATION
- SURFACE STUDIES

SPACE ULTRA–VACUUM FACILITY CONCEPT



WAKE SHIELD TASK

OBJECTIVE: STUDY VIABILITY OF WAKE SHIELD/EXTREME VACUUM FACILITY FOR COMMERCIAL APPLICATIONS

WYLE LABORATORIES - DAVE CHRISTENSEN

UAH - DR. GERALD KARR, M.E.

PROGRAM ELEMENTS:

- BIBLIOGRAPHIC SEARCH
- APPLICATION AND MARKET SURVEY
- CONCEPT DEFINITION
- TECHNOLOGY DEVELOPMENT PLAN
- MISSION ANALYSIS
- EXPERIMENT REQUIREMENTS
- NASA COOPERATIVE PROGRAM (IF APPLICABLE)

WYLE LABORATORIES

ISSUES FOR ULTRA-VACUUM FACILITY FOR SPACE STATION

- Free or attached to Space Station?
- When is facility needed?
- How is facility to be serviced?
- What early experiments are needed?
    - o Verification of vacuum capability
    - o Measurement of contamination levels
    - o Pumping speed determination
    - o Demonstration of processing capability

EXPERIMENT TITLE: SPACE ULTRA-VACUUM FACILITY (WAKE SHIELD)

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - TBD

MASS - TBD KG

VOLUME: TBD

STORED: W ______ x L ______ x H ______ = ______ M^3

DEPLOYED: W ______ x L ______ x H ______ = ______ M^3

INTERNALLY ATTACHED ______ (YES/NO)
EXTERNALLY ATTACHED YES (YES/NO) - BOOM OR TETHER
FORMATION FLYING ______ (YES/NO) POSSIBLE REQ.

ORIENTATION (inertial, solar, earth, other) FLIGHT DIRECTION

EXTRA-VEHICULAR ACTIVITY REQUIRED: YES

SET-UP: TBD Hrs/Day ______ No. of days

OPERATIONS: TBD Hrs/Day ______ No. of days ______ Interval

SERVICING: TBD Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: TBD

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED: SELF CONTAINED (EXP. DEPENDENT)

______ KW AC or DC (circle one)

______ Hrs/Day ______ No. of days

DATA RATE: TBD Megabits/second

DATA STORAGE: TBD Gigabits

RADIATION FROM ATTITUDE CONTROL JETS

MARJORIE PERRIN (UAH)

OBJECTIVE: DEVELOP OPTIMUM ATTITUDE CONTROL JETS THAT GENERATE MINIMUM OPTICAL SIGNALS.

DESCRIPTION: EXPERIENCE WITH THE ATTITUDE CONTROL JETS ON THE SHUTTLE SHOWS THAT THEIR FIRING GENERATES A FLASH OF LIGHT THAT COULD BE DETRIMENTAL TO OPTICAL OBSERVATIONS. THIS PHENOMENA SHOULD ULTIMATELY BE AVOIDED IN SPACE STATION OPERATIONS. TO FIND AND OPTIMUM SOLUTION, A SERIES OF TESTS WITH VARIOUS PROPELLANTS AND SYSTEMS CAN BE CONDUCTED, LEADING TO A NON-INTERFERING ATTITUDE CONTROL SYSTEM.

RADIATION FROM ALTITUDE CONTROL JETS

Observations:

1. Movie pictures taken in darkness show glowing cloud formed when shuttle altitude control jets fired in low Earth orbit.

2. Glowing cloud dissipates in a few seconds.

3. At the same time the surface glow from tail fin brightens, then fades.

HYPOTHESIS: Gas molecules in the thruster exhaust react with, or are collisionally excited by oxygen atoms of kinetic energy 5 eV (8 km/sec). Possible mechanisms are:

(i) $X + O \longrightarrow XO^{*} \longrightarrow XO + \text{light}$

(ii) $X + O \longrightarrow X^{*} + O$

$X^{*} \longrightarrow X + \text{light}$

(These are free-molecule interactions)

Some X is temporarily absorbed on the tail fin and desorbed by action of atomic oxygen again with emission of light.

X may be:

- unreacted thruster gas
- one or more reaction products N_2, CH_4, NH_3, H_2

INVESTIGATION

Goals: Determine the molecule or molecules involved, and the reactions responsible for the glow.

Assess the significance of this phenomena to Space Station.

Generate proposed solutions for Space Station if needed.

Approach: (1) Line spectroscopy of glow to identify molecules.

(2) Measure intensity and spectra of controlled emissions of candidate gases in space; CH_4, NH_3, etc.

(3) Determine the photochemical reactions involved.

(4) Design and test modified or new gas propellants.

RME OBJECTIVES

- o PROVIDE IN-CABIN, REAL TIME RADIATION MEASUREMENT CABABILITY
- o OBTAIN TIME RESOLVED GAMMA-RAY BACKGROUND DATA AND NEUTRON/PROTON BACKGROUND DATA

RADIATION MONITORING EQUIPMENT

HAND-HELD RADIATION MONITOR (HRM-III)

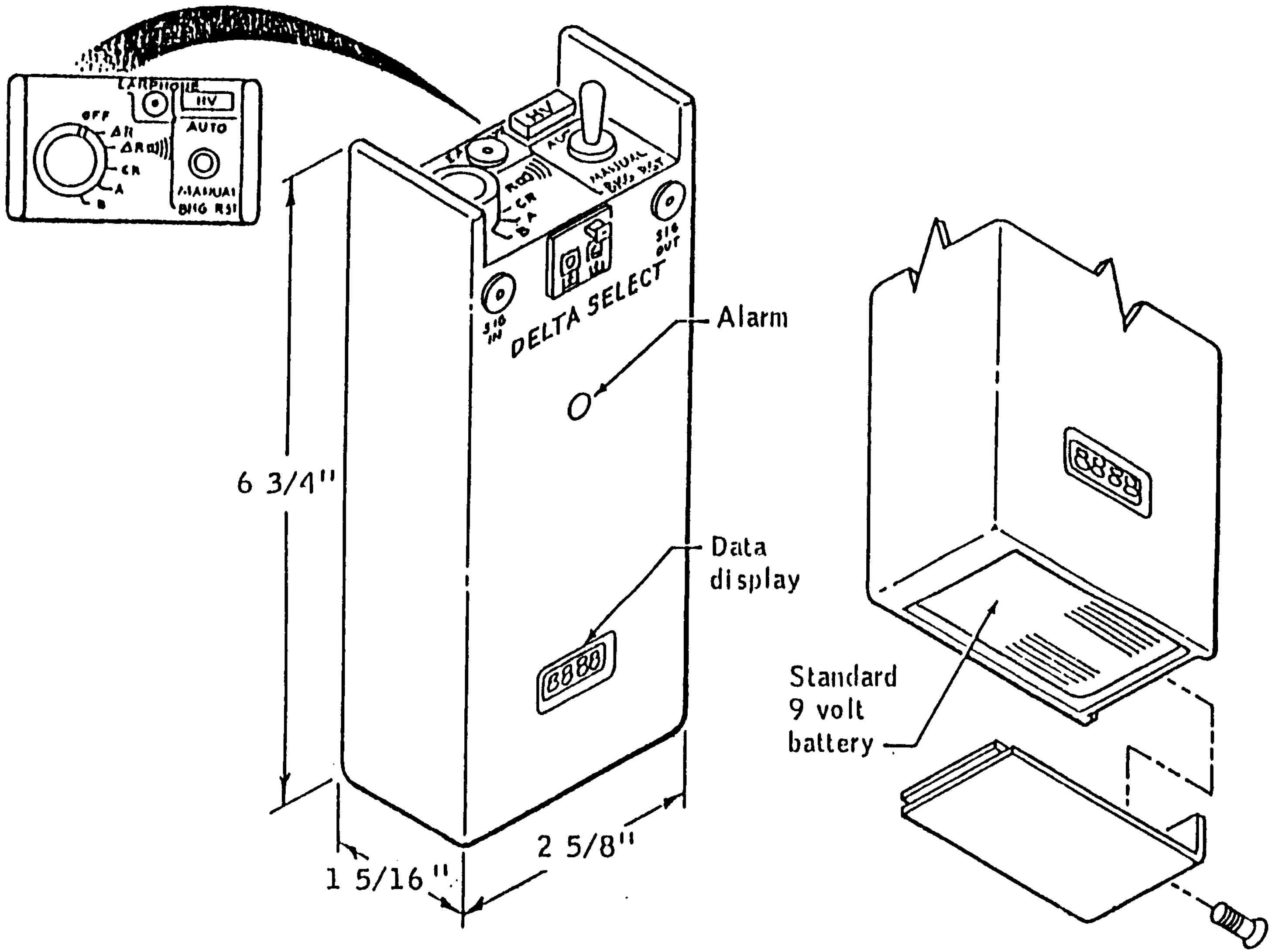
- GAMMA RADIATION MONITOR
- HgI DETECTOR
- SOLID STATE
- SELF CONTAINED
- 6.5 x 3.3 x 17 CM
- .5 KG

SOLID-STATE RECORDER

- FOR USE WITH HRM-III
- 2048 MEMORY LOCATIONS
- SOLID STATE
- SELF CONTAINED
- 13 x 6.5 x 4.5 CM
- .36 KG

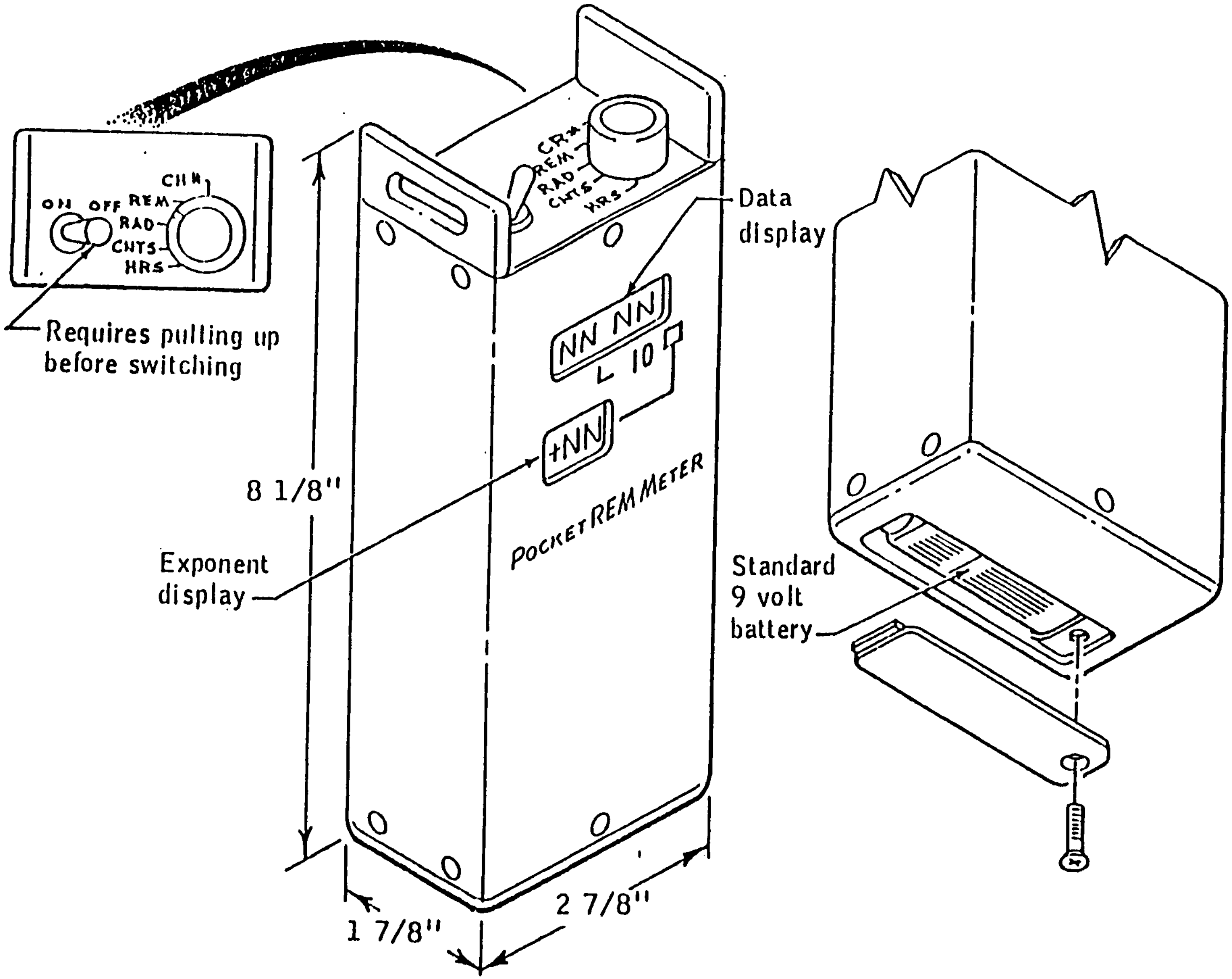
POCKET REM METER (PRM)

- NEUTRON RADIATION MONITOR
- METHANE BASED TISSUE EQUIVALENT GAS
- SOLID STATE
- SELF CONTAINED
- 4.75 x 7.3 x 20.5 CM
- .7 KG



Handheld Radiation Monitor (HRM-III)

Figure 1.



Pocket REM Meter (PRM)

Figure 2.

EXPERIMENT TITLE: Radiation Measurements Experiment (RME)

PROPOSED FLIGHT DATE - THIS YEAR (85)

OPERATIONAL DAYS REQUIRED - continuous

MASS - 1.5 KG

VOLUME:

STORED W ______ x L ______ x H ______ = .25 M^3

DEPLOYED W ______ x L ______ x H ______ = .25 M^3

INTERNALLY ATTACHED YES (~~YES/NO~~)
EXTERNALLY ATTACHED MAYBE (~~YES/NO~~)
FORMATION FLYING NO (~~YES/NO~~)

ORIENTATION (inertial, solar, earth, other) ______

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: .5 Hrs/Day ______ No. of days

OPERATIONS: CONTINUOUS Hrs/Day ______ No. of days ______ Interval

SERVICING ______ Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED:

______ KW AC or DC (circle one)

______ Hrs/Day ______ No. of days

DATA RATE: ______ Megabits/second

DATA STORAGE: ______ Gigabits

ENVIRONMENTAL CONTAMINATION CONTROL CHARACTERIZATION AND VERIFICATION EXPERIMENT

J. TRIOLO AND N. CAROSSO
GSFC CONTAMINATION SECTION, CODE 732
FTS 344-8651

SS ENVIRONMENTAL CONTAMINATION CONTROL CHARACTERIZATION AND VERIFICATION

EXPERIMENT OBJECTIVE

1. TO PROVIDE A TECHNOLOGY BASE AND DATA BASE FOR THE DEVELOPMENT OF SPACE STATION CONTAMINATION CONTROL MANAGEMENT WHICH WILL VERIFY AND REFINE ANALYTICAL ASSESSMENTS, IDENITIFY SOURCES FOR CORRECTIVE ACTION, AND EVENTUALLY LEAD TO AUTOMATIC PROTECTIVE TECHNICQUES FOR CONTAMINATION SENSITIVE MISSIONS.

2. THE PROPOSED MISSION WILL DEVELOP INSTRUMENTATION TO PROVIDE DATA FOR DETERMINATION OF ENVIRONMENTAL PROFILES, SOURCE IDENTIFICATION, EFFECTS ON SURFACE PROPERTIES AND FIELDS OF VIEW, AMBIENT SCATTERING, RE-EMISSION RATE CHANGES CAUSED BY SPACE ENVIRONMENT AND GLOW LEVELS.

3. THE DATA FROM THE FLIGHT INSTRUMENTS WILL BE ANALYZED AND COMPARED WITH CONTAMINATION PREDICTION MODELS. UPDATES TO THE MODELS WILL BE ACCOMPLISHED BASED ON ACCUMULATED DATA.

EXPERIMENT DESCRIPTION

1. EXPERIMENT DESCRIPTION IS NOT YET ESTABLISHED. TECHNOLOGY DEVELOPMENT MUST BE ACCOMPLISHED FIRST.

2. EXPERIMENT WILL CONSIST OF 1)MOLECULAR DEPOSITION AND CHARACTERIZATION MEASUREMENT DEVICES; AND 2) PARTICLE NUMBER AND SIZE MEASUREMENT DEVICES. DEVICES MUST BE RELATIVELY AUTOMATIC WITH BUILT IN ALARMS.

EXPERIMENT TITLE: SS Environmental Contamination Control Characterization & Verification Expmt.

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - Continuous

MASS - TBD KG

VOLUME:

STORED: W ______ x L ______ x H ______ = TBD M^3

DEPLOYED: W ______ x L ______ x H ______ = TBD M^3

INTERNALLY ATTACHED yes (YES/NO) - possibly lab module
EXTERNALLY ATTACHED yes (YES/NO)
FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) Any

EXTRA-VEHICULAR ACTIVITY REQUIRED: TBD

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: TBD

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED: TBD

______ KW AC or DC (circle one)

______ Hrs/Day ______ No. of days

DATA RATE: TBD Megabits/second

DATA STORAGE: TBD Gigabits

Experiment: Environmental Interactions
Presenter: D.B. Snyder, NASA Lewis Research Center

Objective:

Environmental compatibility is vital to the success of future space missions. This series of experiments will evaluate and demonstrate the environmental compatibility of power systems, components of power systems, and space experiments. A complete program to understand the interactions between the space environment and exposed spacecraft components will involve the development of theoretical models, ground tests of models and components, and flight tests. Flight tests for environmental compatibility are vital due to limitations on ground tests. Vacuum tanks impose boundary conditions on systems that do not exist in space. Fight tests will permit large scale testing of systems.

Description:

This program would support a series of flight tests on STS, Space Station and free flying platforms. All these tests require knowledge of the current state of the environment. A separate package of instruments will need to be located far enough from the test area to obtain a good sampling of the environment. This information will be needed to untangle the response of the tested object to the changing environment. In addition, information on the ranges of perturbations on the environment due to the test may be determined by moving this package closer to the test area.

STS can be used in the near future to provide immediate answers. STS can conduct tests dedicated to particular missions or components (e.g., VOLT), or more general tests of small scale systems able to fit in the payload bay and/or be maneuvered on the RMS.

Space Station can be used to conduct large scale tests of long duration. These tests may be run in connection with the operation of a power system test bed facility. These tests will provide information on the coupling between subsystems, degradation of performance due to various interactions, and perturbation of the local environment due to operation of the system.

Free flying platforms may be used to vary the environment experienced by the system. The platforms may be used to vary the flight altitude, and on polar orbits, the plasma environment.

This data will be useful to verify the predicted operation of the system, to allow extrapolation to different environments, and to permit positioning of experiment packages on spacecraft to ensure that they will see space rather than the spacecraft.

DESCRIPTION

Environment Diagnostics* Required for All Tests.

	Test Articles	Objective	Instrumentation	Operations
STS	Dedicated (subscale) Components & Samples Bay & RMS	Concept/Model Validation Scope Impacts Guide Technology	Voltage Control Temperature Control Electrometers Local Sheath & Field Meas. Data Recording Gas Release Plasma Contactors	Vary Ram/Wake Vary Sun Vector Hours/Days Duration
Space Station	Power Test Bed Articles Outboard, Attached Elect. Isolated - Arrays (reconfigurable) - Mirrors, Optical Surfaces - Driven Long Cables - HV Insulation, Coatings, etc.	Long Term Effects (Degradation, Contamination) Science & Operation Interference Power Loss & Interuption Assessment	Voltage/Temp. Control System Electrometers Gas Release Plasma Contactors Operational Diagnostics Data Acquisition Local & Remote Envir. Diag.	Ram/Wake Sun Vector Mag. Field Orientation Article Return Long Term (months)
Platforms	as for SS	Variation in Altitude and Inclination to Obtain Natural Environment Scaling	as for SS	as for SS

*Natural Environment Diagnosics:

Plasma Diagnostics
Plasma Wave Analysis
Electric Field Analysis
Magnetic Field Analysis
Neutral Partical Analysis
(Species, and Energy)

POWER TECHNOLOGY DIVISION

Experiment: ENVIRONMENTAL INTERACTIONS / SPACE POWER TEST BED

Objectives: Evaluate/Demonstrate Environmental Compatibility of Candidate Power System Technologies, to Ensure Successful Function and Operation of Future Space Missions.

* Obtain 'Space Truth'
  - Validate and Calibrate Ground Tests and Models
    Both System and Environment Scaling
  - Ground Simulations are limited.
    Large Distance Scales, Velocities
    Multiple Environment Factors
    System Induced Environment
  - Assess System Induced Effects
    Impact on System/Subsystem Operations
    Impact on Science Experiments

* Evaluate 'Aging' Effects.
  - Chemical (O and/or Contaminants)
  - Sputtering
  - Plasma Currents/Arcing
  - Micrometeoroid & Debris

POWER TECHNOLOGY DIVISION

Environmental Factors Natural & Induced	Impact/Effects	Components	Measurements
Plasma	Power Loss Interuption	Arrays Cables Mirrors HV components	Parasitic Currents Plasma Sheath Arcing Plasma Waves Ram/Wake Effects $v \times B \cdot L$ Efflux
Magnetic Fields	Degradation	Materials Coatings Optical Surf. HV Insulation Arrays	Contamination O degradation Sputtering Micrometeoroids Arc Damage Fatigue (Elec.)
Micrometeoroids & Debris	Operational Interference	all subsystems	Floating Potentials /Charging EMI Subsystem Interactions
Neutral Gas	Science Interference	Space Science Experiments & Packages	Floating Potentials /Charging Plasma Modification Ram/Wake Effects EMI $v \times B \cdot L$ Efflux

EXPERIMENT TITLE: Environmental Interactions / STS

PROPOSED FLIGHT DATE - late 80's to late 90's YEAR

OPERATIONAL DAYS REQUIRED - hours to days

MASS - ______________ KG

VOLUME:

STORED: W ________ x L ________ x H ________ = ________ M^3

DEPLOYED: W ________ x L ________ x H ________ = 6 to 10 M^3

INTERNALLY ATTACHED Yes (YES/NO) Bay
EXTERNALLY ATTACHED Yes (YES/NO)
FORMATION FLYING Yes (YES/NO)

ORIENTATION (inertial, solar, earth, other) Ram/Wake, Sun, Magnetic field

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ________ Hrs/Day ________ No. of days

OPERATIONS: ________ Hrs/Day ________ No. of days ______ Interval

SERVICING: ________ Hrs/Day ________ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ________ Hrs/Day ________ No. of days

OPERATIONS: ________ Hrs/Day ________ No. of days ______ Interval

SERVICING: ________ Hrs/Day ________ No. of days ______ Interval

POWER REQUIRED:

0.5 KW AC or DC (circle one)

24 Hrs/Day ________ No. of days

DATA RATE: 0.05 Megabits/second

DATA STORAGE: 1 Gigabits

EXPERIMENT TITLE: Environmental Interactions / SS

PROPOSED FLIGHT DATE - mid to late '90s YEAR

OPERATIONAL DAYS REQUIRED - months

MASS - 1000 - 5000 KG

VOLUME:

STORED: W ________ x L ________ x H ________ = ________ M^3

DEPLOYED: W ________ x L ________ x H ________ = 600 M^3

INTERNALLY ATTACHED No (YES/NO)
EXTERNALLY ATTACHED Yes (YES/NO)
FORMATION FLYING Yes (YES/NO)

ORIENTATION (inertial, solar, earth, other) Ram/Wake, Solar, Magnetic Field

EXTRA-VEHICULAR ACTIVITY REQUIRED: Yes

SET-UP: ________ Hrs/Day ________ No. of days

OPERATIONS: ________ Hrs/Day ________ No. of days ______ Interval

SERVICING: ________ Hrs/Day ________ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: Not much

SET-UP: ________ Hrs/Day ________ No. of days

OPERATIONS: ________ Hrs/Day ________ No. of days ______ Interval

SERVICING: ________ Hrs/Day ________ No. of days ______ Interval

POWER REQUIRED:

1 KW AC or DC (circle one)

8 to 24 Hrs/Day Months No. of days

DATA RATE: .01 to 1 Megabits/second

DATA STORAGE: 100 Gigabits

FLUIDIZED BED BEHAVIOR IN REDUCED GRAVITY

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CARBOTEK, INC.
HOUSTON, TEXAS

OBJECTIVE:

AVAILABILITY OF REDUCED, CONTROLLABLE GRAVITY IN A SPACE STATION COULD EXTEND THE APPLICABILITY OF FLUIDIZED BEDS TO MUCH LARGER OR DENSER SOLIDS THAN ARE USABLE ON EARTH.

THIS EXPERIMENT SEEKS TO MEASURE IMPORTANT FLUID-SOLIDS PARAMETERS AS FUNCTIONS OF GRAVITY; THESE DATA WILL BE NEEDED FOR SUBSEQUENT DESIGN OF SPACE STATION FLUIDIZED SOLIDS PROCESSING UNITS SUCH AS

- SOLIDS COATING REACTORS
- DRY POWDER MIXERS
- SOLID WASTE PROCESSORS

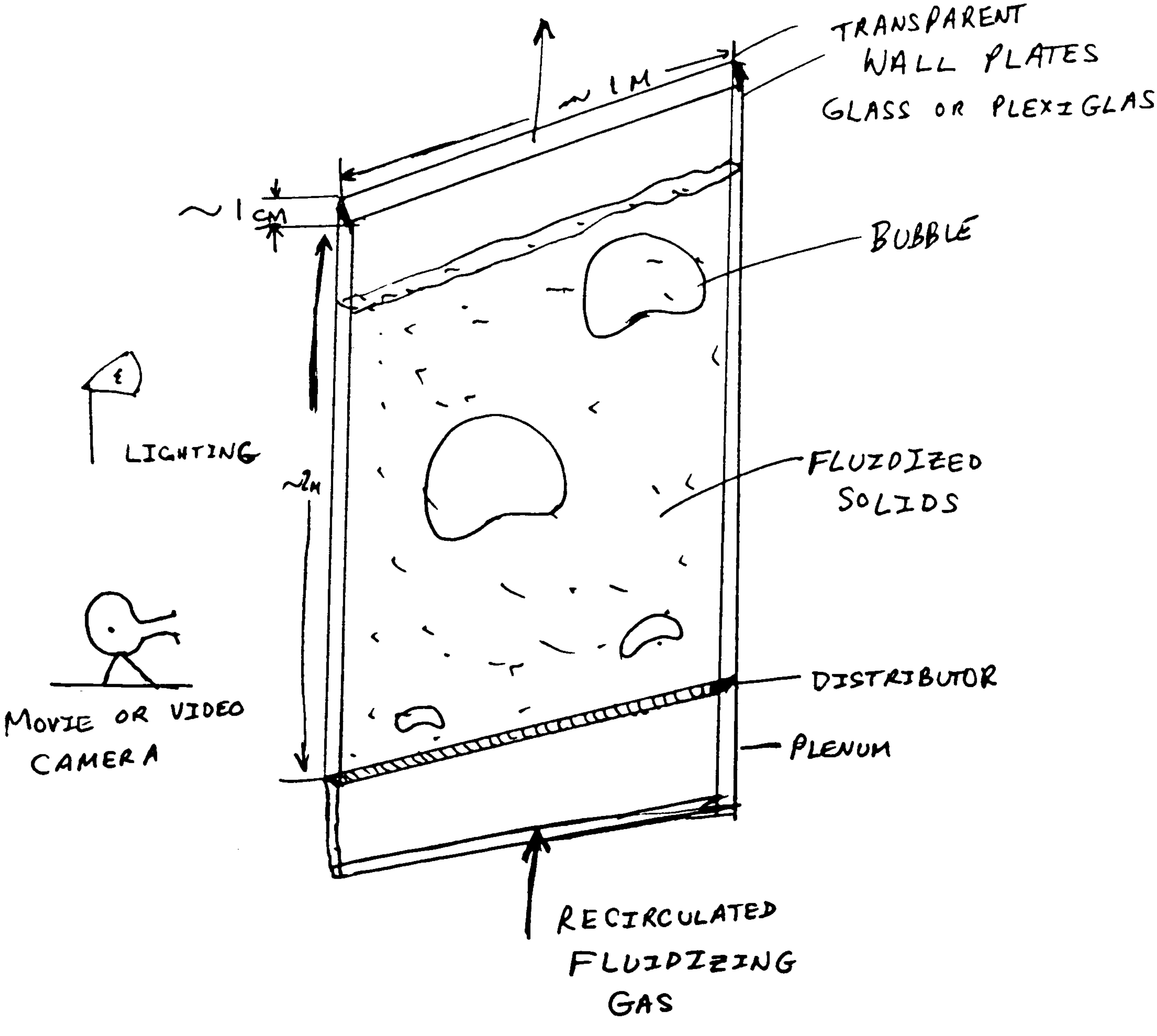
DESCRIPTION:

THE EXPERIMENT CONSISTS OF OPERATING A "TWO-DIMENSIONAL" FLUIDIZED BED WITH VARIOUS COMBINATIONS OF APPLIED GRAVITY, SOLIDS AND FLUIDIZING GAS. IN SUCH A THIN, TRANSPARENT VESSEL, THE CRUCIAL DESIGN PARAMETERS OF GAS BUBBLE SIZE, SHAPE AND GROWTH AND BED EXPANSION CAN BE OBSERVED DIRECTLY AND RECORDED ON FILM OR VIDEOTAPE. NUMEROUS 1g TERRESTRIAL EXPERIMENTS HAVE ESTABLISHED THE VALIDITY OF THIS TECHNIQUE FOR BUBBLE SIZE DETERMINATIONS.

THE ENTIRE EXPERIMENT CAN BE OPERATED AT ROOM TEMPERATURE. THE RANGE OF OTHER INDEPENDENT VARIABLES WOULD BE

- $0.01 < g < 0.3$
- MINIMUM FLUIDIZATION VELOCITY (U_{mf}) < GAS VELOCITY (U) < 90% OF TERMINAL VELOCITY (U_t)
- SOLIDS DIAMETERS UP TO 0.25 CM (2500μ)
- SOLIDS DENSITIES LIMITED ONLY BY $U > U_{mf}$

THE EXPERIMENT WOULD FIT LOGICALLY INTO THE PROPOSED VARIABLE GRAVITY EXPERIMENT FACILITY. IT WOULD NOT REQUIRE LONG-TERM OPERATION OR MONITORING. ONCE SET UP, THE BED FILLED WITH DESIRED SOLIDS AND THE DESIRED GRAVITY ESTABLISHED, ONLY A FEW MINUTES AT EACH CHOSEN GAS VELOCITY WOULD BE NEEDED FOR DATA ACQUISITION.



TWO-DIMENSIONAL, "COLD-MODEL" FLUIDIZED VESSEL FOR SPACE STATION TESTING

EXPERIMENT TITLE: Fluidized Bed Behavior in Reduced Gravity

PROPOSED FLIGHT DATE - ~~TBD~~ 1992 YEAR

OPERATIONAL DAYS REQUIRED - Intermittent ∿30 Total

MASS - 30 KG

VOLUME:

STORED: W 1 x L 2 x H 1 = 2 M^3

DEPLOYED: W 1 x L 2 x H 1 = 2 M^3

INTERNALLY ATTACHED ______ (YES/NO)
EXTERNALLY ATTACHED ______ (YES/NO)
FORMATION FLYING ______ (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A - None

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 4 Hrs/Day 5-10 No. of days

OPERATIONS: 2 Hrs/Day 30 No. of days ______ Interval

SERVICING: 2 Hrs/Day 5 No. of days ______ Interval

POWER REQUIRED:

∿1 KW AC or DC (circle one)

______ Hrs/Day ______ No. of days

DATA RATE: N/A Megabits/second

DATA STORAGE: N/A Gigabits

CONTROLLED THRUST PROPULSION TECHNOLOGY

OBJECTIVE: TO PROVIDE A SPACE STATION BASED CAPABILITY FOR TEST AND EVALUATION OF THE PERFORMANCE, LIFETIME, AND INTEGRATION CHARACTERISTICS OF ADVANCED LOW-THRUST PROPULSION SYSTEMS– ELECTRICAL, CHEMICAL AND ADVANCED CONCEPTS.

JUSTIFICATION: GROUND FACILITIES ARE NOT CAPABLE OF PROVIDING ACCURATE DATA REQUIRED FOR APPLICATION OF NEW PROPULSION CONCEPTS TO SPACECRAFT, E.G.–

- PARTICULATE EFFLUX IN REAR AND FORWARD HEMISPHERE
- EMI SPECTRUM, LEVEL, AND PATTERN

NO TOTALLY SATIFACTORY MEANS OF TESTING AND EVALUATION EXIST WITH GROUND-BASED FACILITIES FOR–

- HIGH TEMPERATURE THRUSTER LIFE AND PERFORMANCE
- CORRELATION OF SPACE AND GROUND DATA.

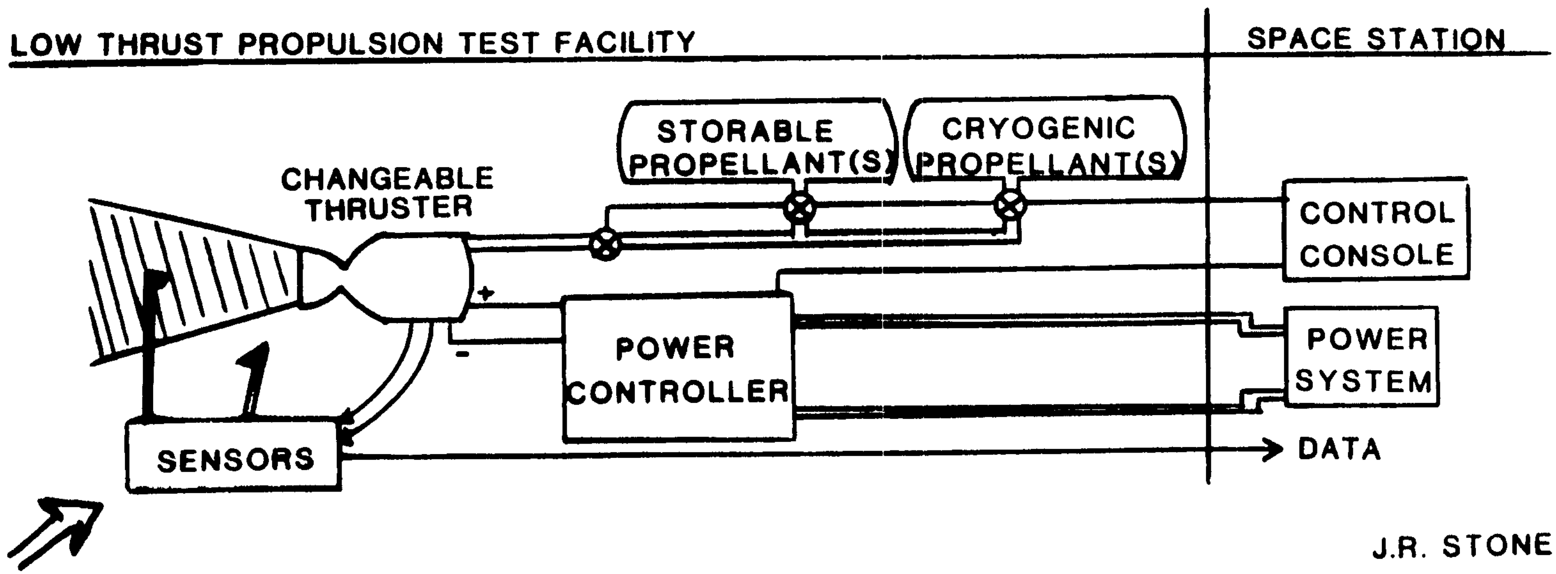
SPACE DEMONSTRATION OF NEW TECHNOLOGY GENERALLY REQUIRED PRIOR TO APPLICATION.

J.R. STONE

CONTROLLED THRUST PROPULSION TECHNOLOGY

DESCRIPTION: SPACE STATION BASED FACILITY WITH FLEXIBILITY TO TEST AND CHARACTERIZE ACCURATELY ADVANCED AUXILIARY PROPULSION SYSTEMS FOR:

- PARTICULATE EFFLUX
- PERFORMANCE
- E.M.I.
- LIFE



J.R. STONE

EXPERIMENT TITLE: CONTROLLED ACCELERATION PROPULSION TECHNOLOGY

PROPOSED FLIGHT DATE - 1992 YEAR (FACILITY BUILD-UP AND CHECK-OUT) FOLLOWED BY AN ONGOING SERIES OF SPECIFIC EXPERIMENTS)

OPERATIONAL DAYS REQUIRED - 5 FOR BUILD-UP AND CHECK-OUT, FOLLOWED BY AN ONGOING SERIES OF SPECIFIC EXPERIMENTS OF 10 DAYS TYPICAL DURATION.

MASS - 200 KG

VOLUME:

STORED: W 2 M x L 2 M x H 2M = 8 M^3

DEPLOYED: W 2M x L 6M x H 2M = 24 M^3 (OPEN TO SPACE)

INTERNALLY ATTACHED ________ (~~YES~~/NO)

EXTERNALLY ATTACHED ________ (YES/~~NO~~)

FORMATION FLYING ________ (~~YES~~/NO)

ORIENTATION (inertial, solar, earth, other) VARIABLE (TO PROVIDE RANGE OF PRESSURE)

EXTRA-VEHICULAR ACTIVITY REQUIRED: (PER EXPERIMENT) TYPICAL)

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: 0 Hrs/Day 0 No. of days 0 Interval

SERVICING: 2 Hrs/Day 1 No. of days 5 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: (PER EXPERIMENT, TYPICAL)

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: 2 Hrs/Day 10 No. of days 1 Interval

SERVICING: 2 Hrs/Day 1 No. of days 5 Interval

POWER REQUIRED:

UP TO 30* KW AC or DC ~~(circle one)~~ (DEPENDENT ON SPECIFIC EXPERIMENT)

10 Hrs/Day 10 No. of days (TYPICAL)

DATA RATE: ~ 1 Megabits/second

DATA STORAGE: ~1 Gigabits

* For runs of up to 1 hr duration → 30 kW-hr requirement, which can be accomodated by lower istantaneous requirement using storage with charging during non-operating time. - Would add some mass & volume

J.R. STONE

SPACECRAFT GLOW AND EROSION

-- *ATOMIC-SCALE INTERACTIONS*

-- *ELECTRON, PHOTON BEAMS*

-- *NEUTRAL OXYGEN BEAMS*

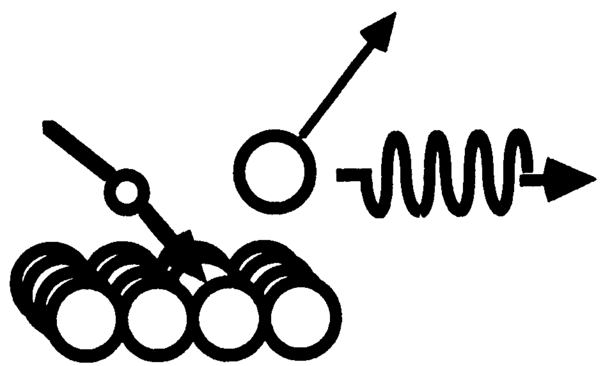
-- *ENERGY-SURFACE INTERACTIONS*

ROYAL ALBRIDGE

RICHARD HAGLUND

NORMAN TOLK

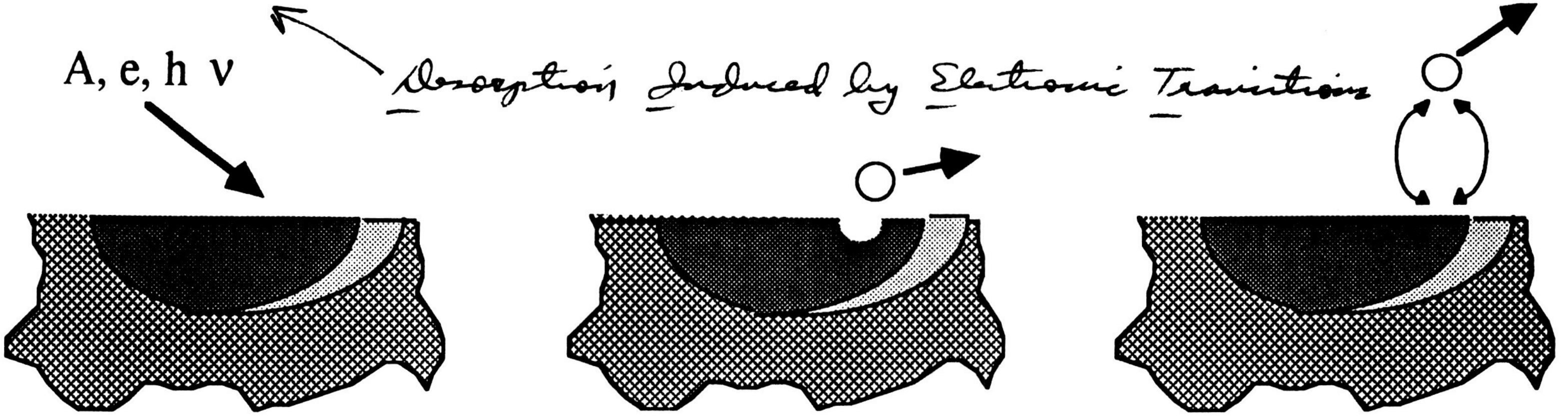
SUPPORTED IN PART BY MARTIN MARIETTA AEROSPACE



THE CENTER FOR ATOMIC PHYSICS AT SURFACES
DEPARTMENT OF PHYSICS AND ASTRONOMY
VANDERBILT UNIVERSITY
NASHVILLE, TENNESSEE 37235

DIET CAUSES EROSION AND GLOW

Desorption Induced by Electronic Transitions

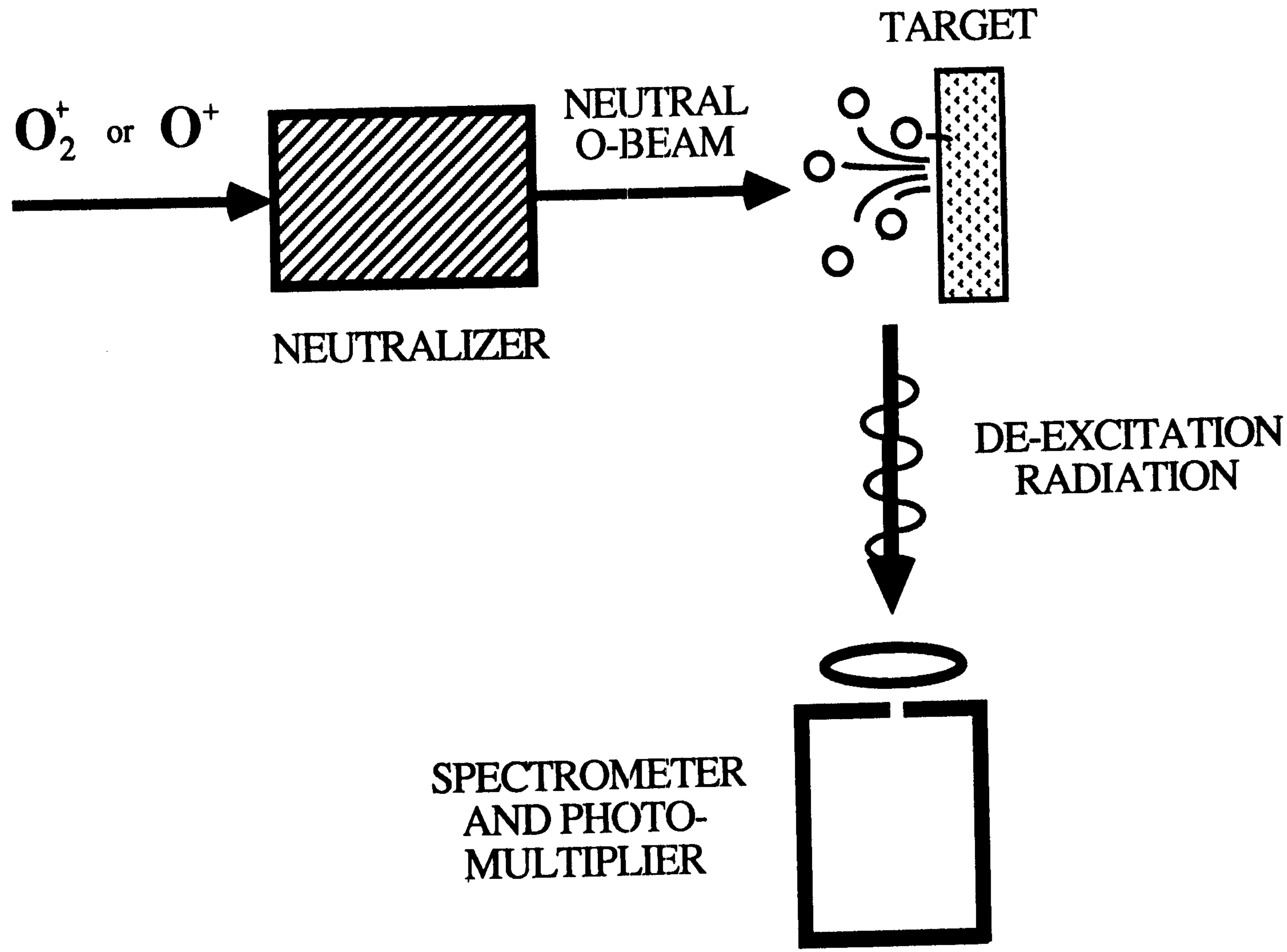


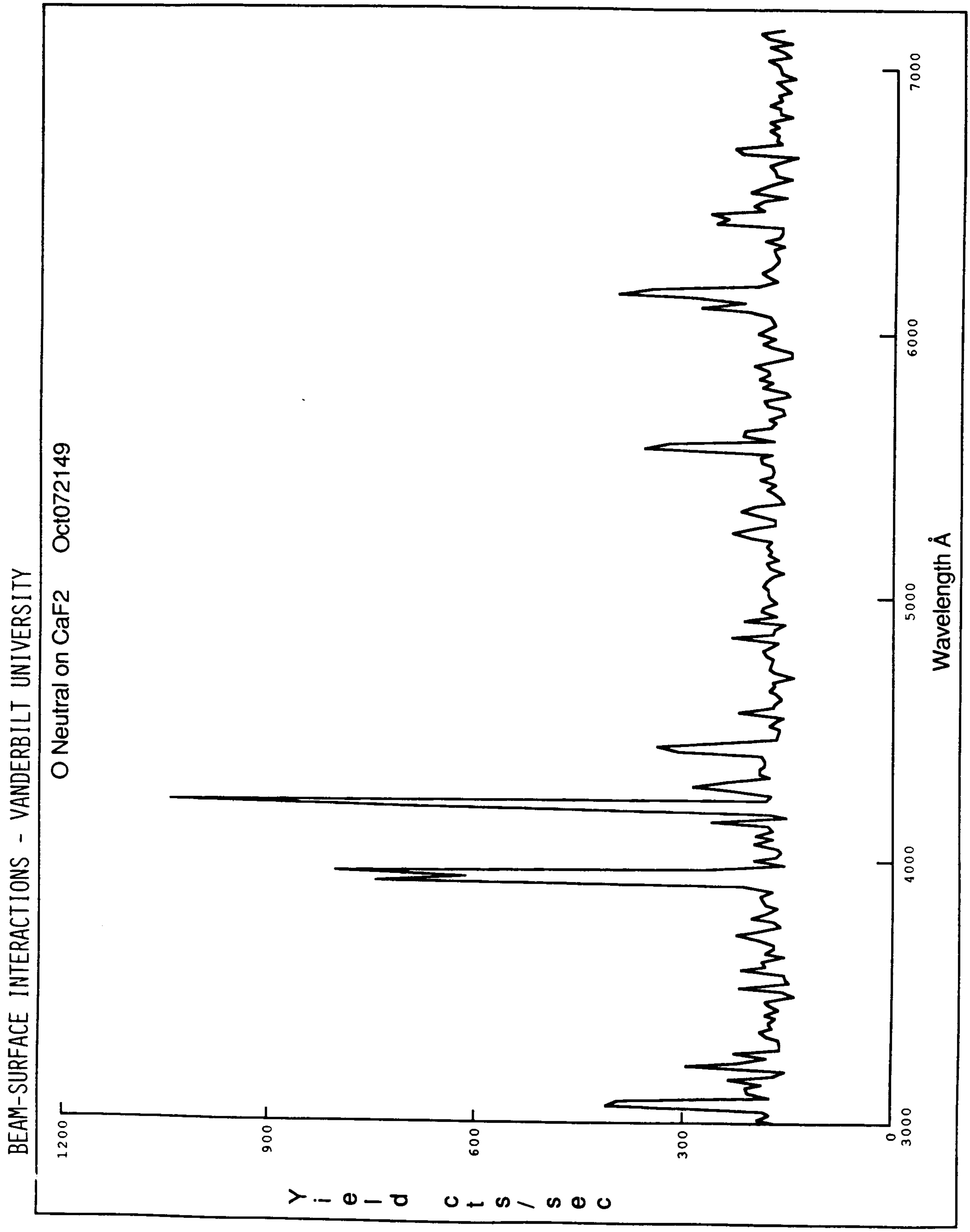
EXCITATION | EJECTION | PARTICLE-SURFACE ELECTRONIC INTERACTIONS

- **THERMAL, PLASMA, SPUTTERING AND ELECTRONIC PROCESSES ALL CONTRIBUTE**
- **DIET ESPECIALLY EFFECTIVE ON INSULATORS (OPTICAL MATERIALS, POLYMERS, COMPOSITES)**
- **LONG-LIVED, MOBILE ELECTRONIC DEFECTS APPEAR TO PLAY A CRITICAL ROLE**

VANDERBILT UNIVERSITY

NEUTRAL O-BEAM FACILITY

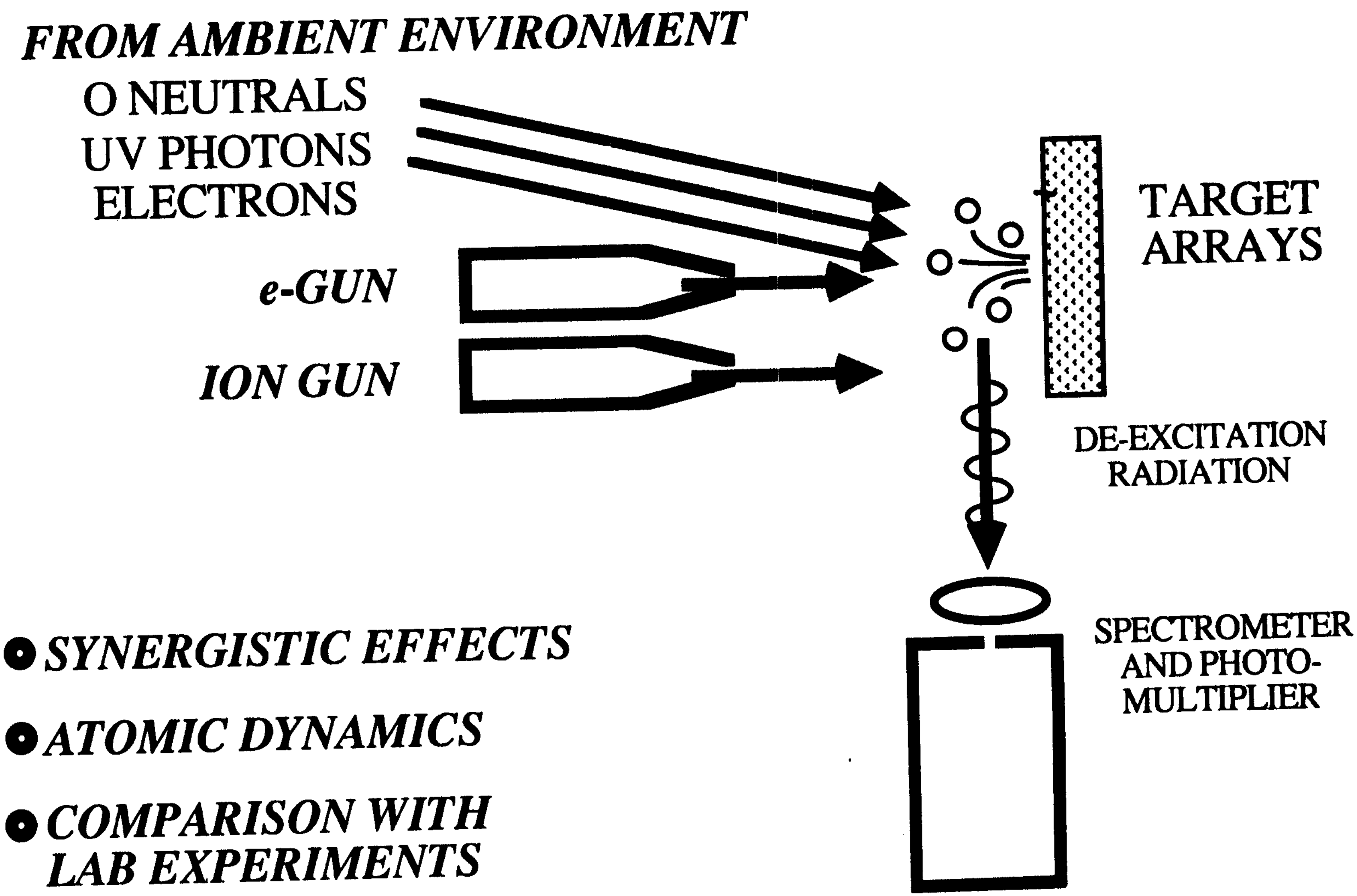




BEAM-SURFACE INTERACTIONS - VANDERBILT UNIVERSITY
O Neutral on CaF2
Oct072149
1200
900
600
300
0
3000
4000
5000
6000
7000
Wavelength Å
Yield
cts/sec

BEAM-SURFACE INTERACTIONS
VANDERBILT UNIVERSITY

IN-SITU MEASUREMENTS OF SURFACE DAMAGE, GLOW AND EROSION IN THE SPACE STATION



- ***SYNERGISTIC EFFECTS***
- ***ATOMIC DYNAMICS***
- ***COMPARISON WITH LAB EXPERIMENTS***

BEAM-SURFACE INTERACTIONS
VANDERBILT UNIVERSITY

EXPERIMENT TITLE: Synergistic Effects in Beam-Surface Interactions

PROPOSED FLIGHT DATE - 1991 **YEAR**

OPERATIONAL DAYS REQUIRED - 90

MASS - 150 **KG**

VOLUME:

STORED: W 1.70 cm x L 1.50 cm x H 40 cm = 1 M^3

DEPLOYED: W same x L same x H same = same M^3

INTERNALLY ATTACHED yes (YES/NO)
EXTERNALLY ATTACHED ______ (YES/NO)
FORMATION FLYING ______ (YES/NO)

ORIENTATION (inertial, solar, earth, other) solar

EXTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: ______ Hrs/Day ______ No. of days

OPERATIONS: ______ Hrs/Day ______ No. of days ______ Interval

SERVICING: ______ Hrs/Day ______ No. of days ______ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 1 Hrs/Day 30 No. of days

OPERATIONS: 2 Hrs/Day 90 No. of days ______ Interval

SERVICING: ? Hrs/Day ______ No. of days ______ Interval

POWER REQUIRED:

0.1 KW AC or DC (circle one)

continuous Hrs/Day 90 No. of days

DATA RATE: 0.1 Megabits/second

DATA STORAGE: ______ Gigabits

A PLASMA PHYSICS CONSTITUENCY FOR SPACE STATION?

Ed Szuszczewicz
Plasma Physics Div
Science Applications Int'l Corp.
McLean, VA

A PERSPECTIVE ON

1) Workshop Objectives
2) Environmental Effects
3) Space Station as a Unique Plasma Lab
4) User Needs

① WHY ARE WE HERE?

- Develop a constituency in support of space station

② WHAT IS THE SPACE STATION?

- A "semi-defined" platform in spac that

  a) Will be permanent
  b) Will grow
  c) Will be permanently mann
  d) Will be in LEO (@250 n.m)

③ "FINAL" design will be dictated by the potential users

POTENTIAL USES TO THE PLASMA COMMUNITY

A) Basic plasma experiments untenable in a ground-based laboratory

B) Geophysical and astrophysical plasma plasma experiments (active and passive)

Usefullness affected by

- NATURAL LEO ENVIRONMENT
- INDUCED ENVIRONMENT

NATURAL vs INDUCED

ENVIRONMENTS

THE NATURAL ENVIRONMENT

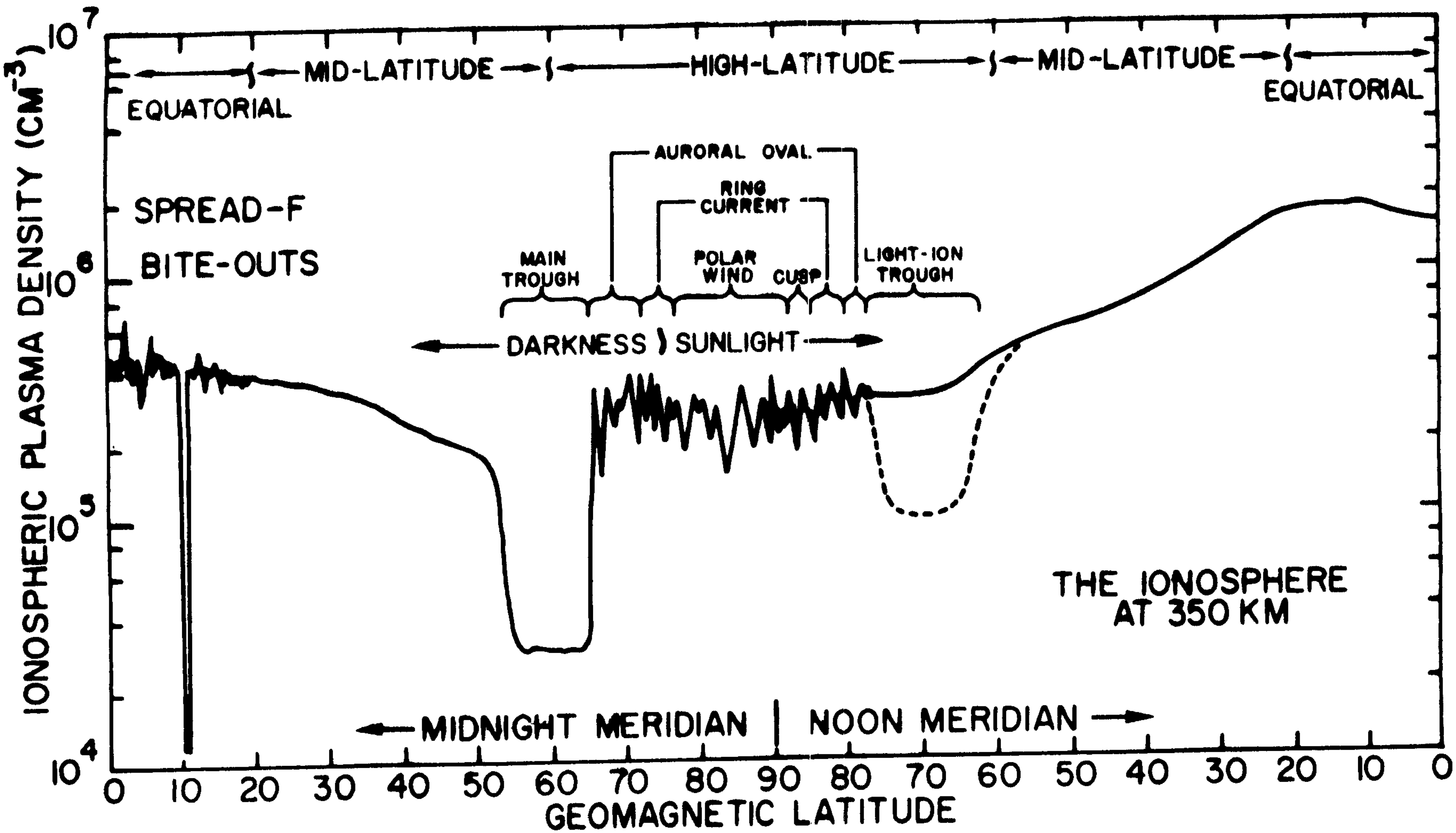
1) Reasonably <u>well</u> understood (i.e., on the average ... but not predictable on a day-to-day, hour-by-hour basis)

2) Can conduct 15 minute experiments (if NO INDUCED ENVIRONMENTAL EFFECTS in <u>basic</u> plasma, <u>geo</u>plasma and <u>astro</u>physical plasma physics

3) Space Station can PROVIDE permanent solar-terrestrial monitoring systems (NAS priority ... flow of energy and mass in the solar-magnetospheric-ionospheric-thermospheric system

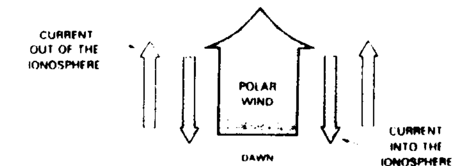
RELEVANT TO: ISTP (NASA + World)

SUNDIAL (NSF + World)

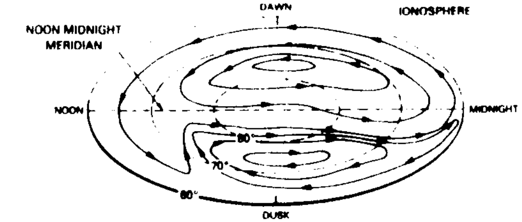

EQUATORIAL
MID-LATITUDE
HIGH-LATITUDE
MID-LATITUDE
EQUATORIAL
SPREAD-F
BITE-OUTS
AURORAL OVAL
RING CURRENT
MAIN TROUGH
POLAR WIND
CUSP
LIGHT-ION TROUGH
DARKNESS) SUNLIGHT
THE IONOSPHERE AT 350 KM
MIDNIGHT MERIDIAN
NOON MERIDIAN
IONOSPHERIC PLASMA DENSITY (CM^{-3})
GEOMAGNETIC LATITUDE
10^7
10^6
10^5
10^4
0 10 20 30 40 50 60 70 80 90 80 70 60 50 40 30 20 10 0

THE HIGH-LATITUDE IONOSPHERE

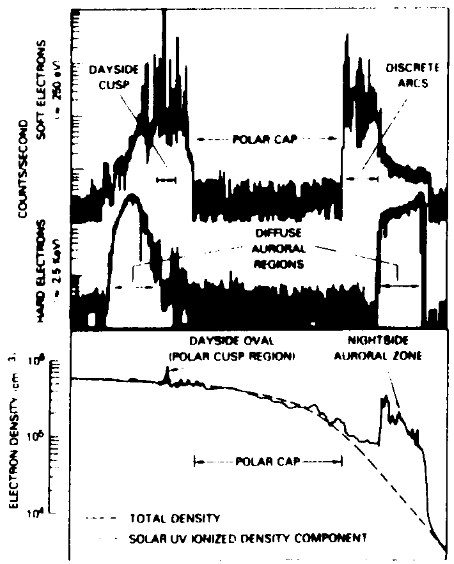
PHENOMENOLOGY, IRREGULARITY DISTRIBUTIONS, TRANSPORT AND MAGNETOSPHERIC COUPLING



THE POLAR WIND
AND
FIELD-ALIGNED CURRENTS
IN THE
IONOSPHERIC-MAGNETOSPHERIC
SYSTEM

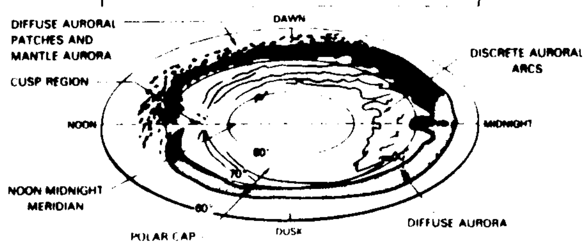


MAGNETOSPHERICALLY
IMPOSED
CONVECTION PATTERN



TYPICAL PRECIPITATING
ELECTRON DISTRIBUTIONS
NEAR 1000 km IN THE
NOON-MIDNIGHT MERIDIAN

"IN SITU" PLASMA DENSITY
NEAR 200 km IN THE
NOON-MIDNIGHT MERIDIAN



OPTICAL
SIGNATURES
OF HIGH LATITUDE
PHENOMENOLOGY

INDUCED ENVIRONMENT ...

A POTENTIAL SERIOUS THREAT

1) Gaseous Effluents

- Virtual Leaks
- ACS, OMS, Vernier Firings
- Real Leaks
- Thermal Control Systems

a) Electrical and Optical Surface Property Modification

b) Modification of Natural Environment

- Chemistry → Local Ionospheric Holes
- Induced Plasma Phenomena

  e.g. Critical Ionization (Alven CIV)

- Plasma Turbulence

2) Uncontrolled Potentials and Surfaces

- Solar Panel Arrays
- Inventory of Active Electrodes
- High power, high voltage systems
- Poor conductor and insulator surfaces

3) Electrical & Magnetic Contamination

- Stray electric and magnetic fields
- Switching Circuit Transients
- EMI/EMC

→ Can affect local plasma environment and plasma diagnostic devices

THE BASIC PLASMA, GEOPLASMA AND

ASTROPHYSICAL PLASMA COMMUNITIES

CAN BE

A STRONG SUPPORTER OF THE SPACE STATION

AS A <u>UNIQUELY USEFUL LABORATORY IN SPACE</u>

<u>IF AND ONLY IF</u>

<u>INDUCED ENVIRONMENTAL EFFECTS ARE ELIMINATED</u>